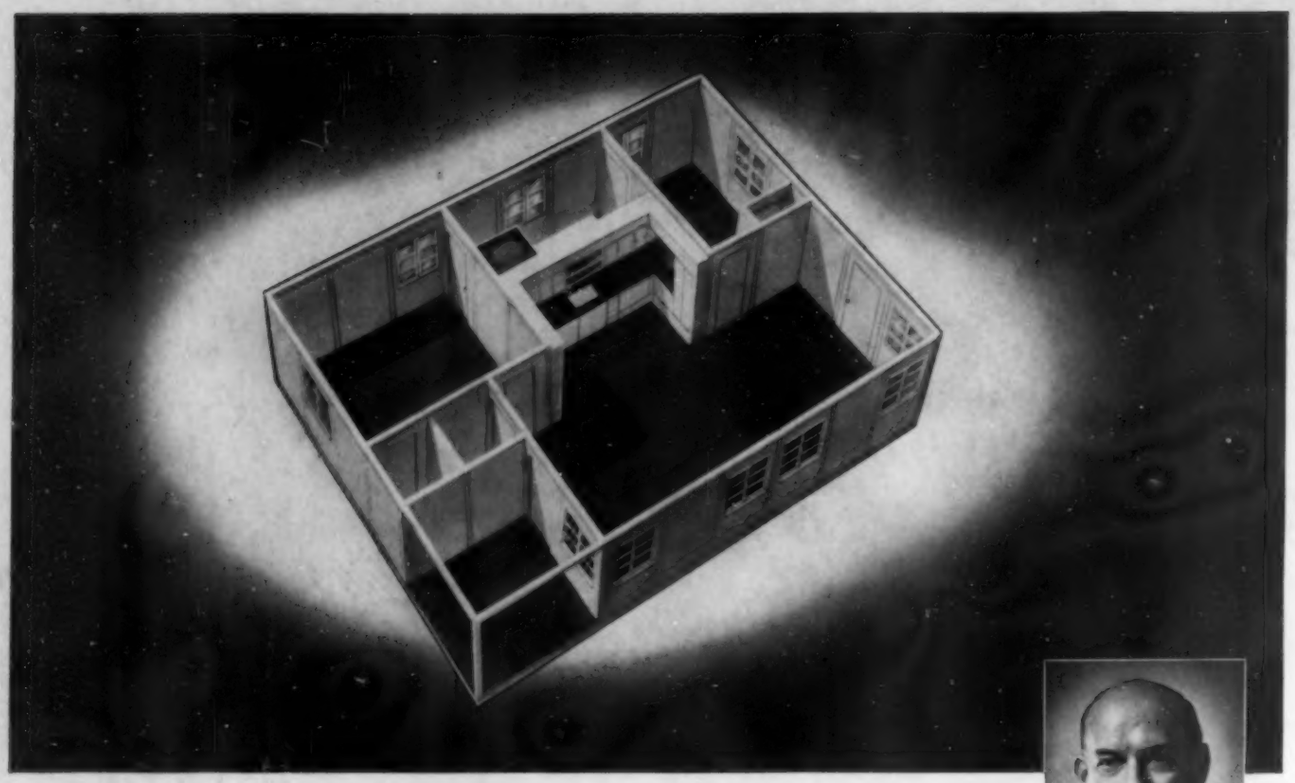
MODERN PLASTICS

FEBRUARY 1942



Let's look at tomorrow

Walter Dorwin Teague, Industrial Designer

IT'S SPRING, 19??... Mrs. America has finally persuaded "Jim" to trade in their house for the brand new model that's just out. This year, he thinks they'll even be able to afford the Summer air-conditioning "accessory." For, delivered, the whole house comes to only $2,000—without even allowing for the trade-in!

SUCH A HOME, as visualized here, will be made a practical reality through the use of Durez resin-bonded plywood and other new structural materials. But let Walter Dorwin Teague tell you about the plywood prefabricated house...

"Post-war development of the prefabricated house will revolutionize the housing problem for the average man just as efficiently as the automobile has solved his transportation difficulties. Right from the assembly line... it will come complete with built-in kitchen, automatic heat and air conditioning, refrigeration, radio and telephone."

Exterior and interior walls and roof will utilize Durez-bonded plywood—sheets of wood that are permanently fastened or bonded together with Durez phenolic resins. While extremely light, this plywood is tough and weather-resistant—economical to make and easy to handle from both the standpoint of design and mass-production assembly.

This is no idle dream—any more than the automobile was in 1916. Spurred by the needs of defense housing, the Government is now encouraging the rapid development of prefabricated houses. As the result of this tremendous impetus, you'll be enjoying the advantages of a reasonably-priced, completely modern home sooner than you think.

But right now, all America is engaged in winning the war. From the plant—from the laboratory—Durez phenolic molding compounds and resins and new formulae go into war-material production or to the manufacturers of civilian essentials.

Yet all Industry, working overtime today, must shoulder still another responsibility. Industry must also plan ahead for a victorious America. Industry must know what it can do with plastics—the materials of tomorrow. A request on your letterhead will bring DUREZ PLASTICS NEWS to your desk every month.

DUREZ...plastics that fit the job

DUREZ PLASTICS & CHEMICALS, INC. DUREZ 1122 WALCK ROAD, N. TONAWANDA, N. Y.

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DETROIT

VISUAL SIGNALS OF TRANSLUCENT *Catalin* ARE NOW ON ENGINE ROOM DUTY WITH OUR NAVY!

To join the Navy . . . a material, too, must be physically fit! In this application, a visual signal control, Catalin's translucency proved to be an important acceptance factor. This, plus Catalin's strength, chemical resistance, non-inflammability and sea-worthiness. Its smooth surface lends itself readily to silk screening, roll leaf stamping, metal plating, engraving, inlaying, etc.

Today, the national effort demands the utmost of every material—and with the utmost of speed. Catalin, available in sheets, rods and tubes can be *quickly* fabricated into finished parts on standard shop equipment. Even special shapes, regardless of size or thickness, can be *quickly* tooled up for and *quickly* cast! And without need for expensive molds or molding machinery. All of this is good news—especially at this moment when every minute counts! Catalin's facilities are yours to command! How can we serve you?

THE Catalin FAMILY OF MODERN PLASTICS

Catalin® AND *Prystal*®
CAST PHENOLIC RESINS
TECHNICAL CAST RESINS

Loalin®
POLYSTYRENE MOLDING COMPOUNDS

Catabond® AND *Catavar*®
MELAMINE AND PHENOL-FORMALDEHYDE LIQUID RESINS

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CATALIN CORPORATION • ONE PARK AVENUE, NEW YORK, N. Y.

MORE PLASTICS FOR LEADING CAR MAKERS

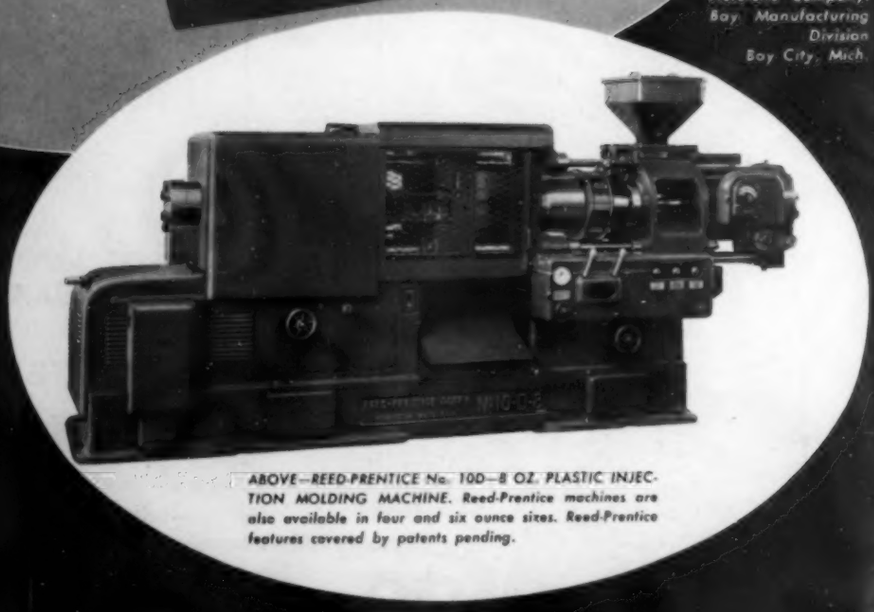
MOLDED ON *REED-PRENTICE* MACHINES

MOLDER
The Electric Auto-Lite Company. Bay Manufacturing Division
Bay City, Mich.

Releasing needed metals for defense, the use of injection molded plastics also cuts out costly finishing operations and lends new beauty of design and color to modern automobiles. Notice the wide range of size, function, and ingenious use of inserts in the typical group shown above.

Reed-Prentice molding machines are top choice among leading molders for dependable, economical performance and are flexible and adaptable in handling any of the well-known thermoplastic molding powders.

Detailed proposals gladly submitted on request . . . no obligation, of course.



ABOVE—REED-PRENTICE No. 10D—8 OZ. PLASTIC INJECTION MOLDING MACHINE. Reed-Prentice machines are also available in four and six ounce sizes. Reed-Prentice features covered by patents pending.

REED-PRENTICE CORPORATION 1213 W. 3d St., CLEVELAND, OHIO
75 WEST ST., NEW YORK CITY

WORCESTER, MASSACHUSETTS, U.S.A.

469 MACHINES IN SUCCESSFUL OPERATION

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modern plastics

FEBRUARY 1942

VOLUME 19 NUMBER 6

FOR THE DURATION

Readers of MODERN PLASTICS will not fail to notice some changes in its format, dictated by our desire to conserve paper, metal and colored pigment. In the past we have taken pride in the appearance of our magazine and we shall continue to do so, knowing that our type is smaller so that America's bombers may be bigger. We shall have fewer illustrations so that our Navy may have more ships; and there will be less color on our pages so that those our soldiers are now writing for the great book of recorded history will glow with greater brilliance.

We can assure our readers that our editorial standards will in no way be lowered, that we shall continue to inform them fully of significant advances in the plastics industry—in short, that under our new war uniform we are the same MODERN PLASTICS.

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E. R. GORDON, Production
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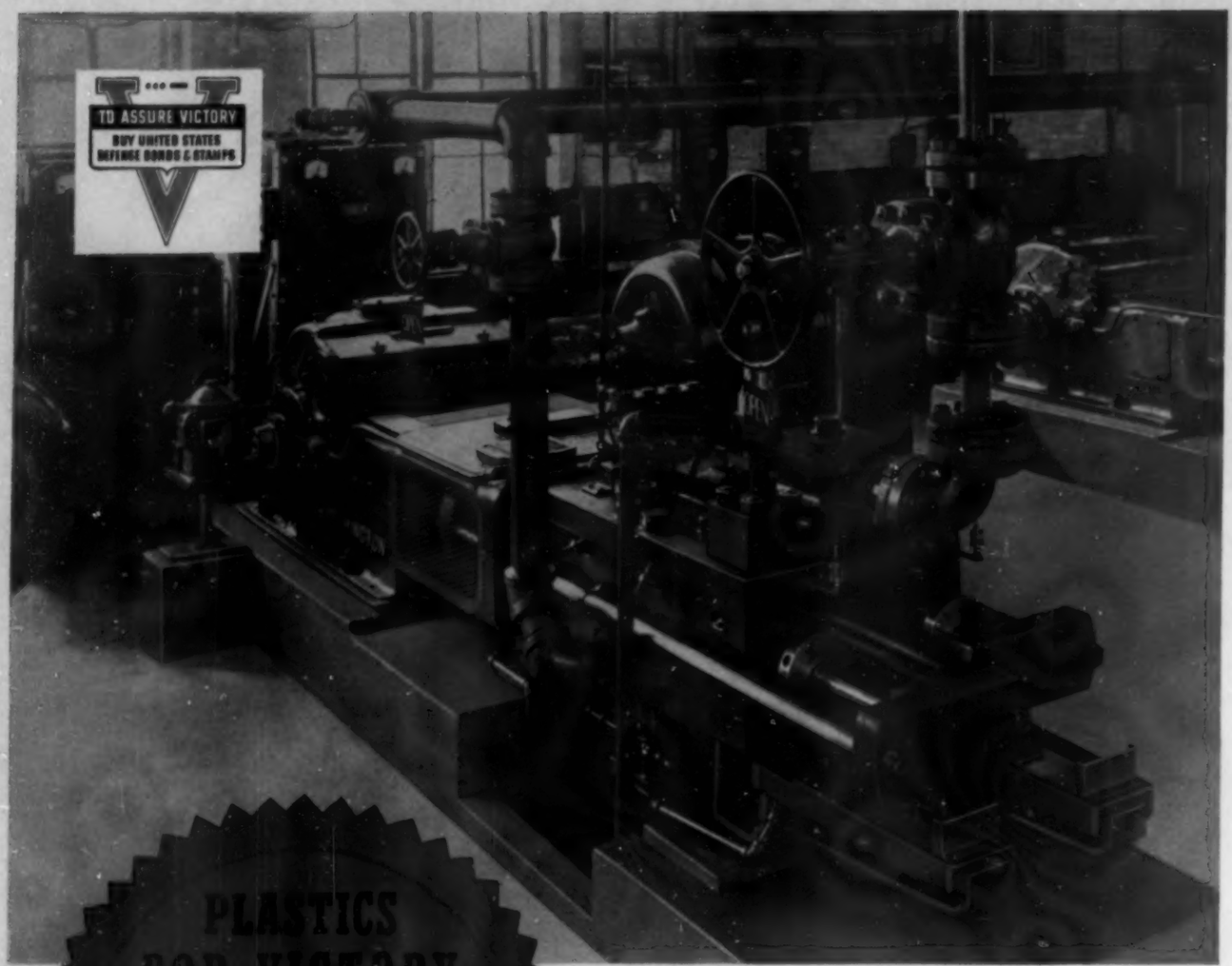

2½ x 12 Worthington Type KUF Power Pumps equipped with Timken Bearings installed in one of the country's largest plastics molding plants.

Each pump is designed for a capacity of 70 GPM at 2,000 lbs. working pressure and is driven by a 100 H.P., 514 RPM synchronous motor.

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Timken Bearing Equipped machines will help to make the plastics that will help to win the war—and the economic struggle that will follow it.

Machines used in the production of plastics —whether of standard or specialized types— need the protection of Timken Tapered Roller Bearings as much as the equipment employed in any other industry.

They need their frictionless smoothness; accuracy; radial, thrust and combined load capacity; and endurance.

It will pay you—now and in the future—to see that they get them.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

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TAPERED ROLLER BEARINGS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

...it's made with Du Pont "PYRALIN"

YOU KNOW how easy it is to damage soft metals by blows from hard tools. Airplane manufacturers had this problem with aluminum—ordinary hammers often injured the expensive, hard-to-obtain sheets. They tried special wood, rubber and fibre mallets. But these didn't stand the gaff.

The answer—Du Pont "Pyralin"—came from an unexpected quarter. The plane makers learned that silversmiths were successfully using "Pyralin" hammer heads to form gold, silver, brass, copper and pewter. They discovered "Pyralin" was just the material for hammer-working sheet aluminum.

These "Pyralin" hammer heads do not chip, break or mark the metal. Transparent and clean, they resist water, oil or grease, and do not deteriorate appreciably with age. And in a series of tests conducted by manufacturers, they outwore each of the previously used types of soft mallets.

Consider Du Pont "Pyralin" cellulose nitrate plastic for *your* future products. It's light in weight...strong and durable... little affected by moisture or chemicals. It comes in beautiful decorative colors—opaque, mottled, translucent or transparent. It is inexpensive compared to other clear plastics and comes in easily worked sheets, rods and tubes.

You are welcome to samples, full information, technical assistance and information on availability of "Pyralin" and the other Du Pont plastics. These include "Lucite" methyl methacrylate resin . . . "Plastacele" cellulose acetate plastic . . . and nylon in single filament form.

E. I. du Pont de Nemours & Co. (Inc.)
Plastics Department, Arlington, N. J.

"Pyralin," "Plastacele," "Lucite" are Reg. U. S. Pat. Off.

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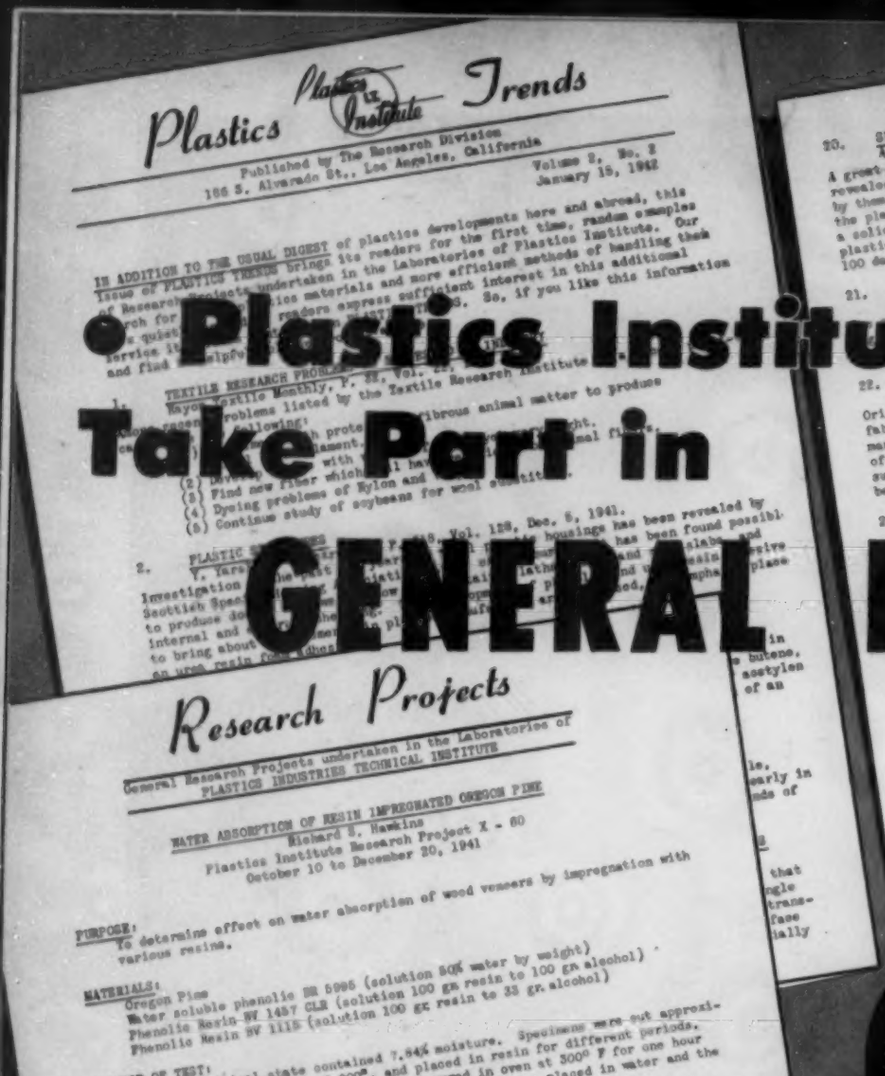
PLASTICS

Listen to "Cavalcade of America" every Monday evening over coast-to-coast NBC Red Network

Plastics Institute Students Take Part in GENERAL RESEARCH



Plastics Trends

Published by The Research Division
186 S. Alvarado St., Los Angeles, California

Volume 2, No. 2
January 15, 1942

IN ADDITION TO THE USUAL DIGEST of plastics developments here and abroad, this issue of PLASTICS TRENDS brings its readers for the first time, random samples of Research projects undertaken in the Laboratories of Plastics Institute. Our research for [illegible] materials and more efficient methods of handling them service it readers express sufficient interest in this additional and find [illegible]. So, if you like this information

1. TEXTILE RESEARCH PROBLEMS, P. 23, Vol. 22, Mayo Textile Monthly. The Textile Research Institute [illegible] problems listed by the Textile Research Institute [illegible] fibrous animal matter to produce [illegible] following:
(1) [illegible]
(2) [illegible]
(3) Find new fiber which [illegible]
(4) Dyeing problems of Nylon and [illegible]
(5) Continue study of soybeans for wool [illegible]

2. PLASTIC [illegible], P. [illegible], Vol. 128, Dec. 6, 1941. [illegible] housings has been revealed by Investigation [illegible] has been found possible Scottish Spec[illegible] to produce [illegible] internal and [illegible] to bring about [illegible] an urea resin from [illegible]

Research Projects

General Research Projects undertaken in the Laboratories of PLASTICS INDUSTRIES TECHNICAL INSTITUTE

WATER ABSORPTION OF RESIN IMPREGNATED OREGON PINE
Richard S. Hawkins
Plastics Institute Research Project X - 60
October 10 to December 20, 1941

PURPOSE:
To determine effect on water absorption of wood veneers by impregnation with various resins.

MATERIALS:
Oregon Pine
Water Soluble Phenolic BR 5996 (solution 50% water by weight)
Phenolic Resin BV 1457 CLR (solution 100 gm resin to 100 gm alcohol)
Phenolic Resin BV 1115 (solution 100 gm resin to 33 gm. alcohol)

METHOD OF TEST:
Wood in original state contained 7.84% moisture. Specimens were cut approximately .250" x 1.000" x 3.000", and placed in resin for different periods. (see table) at room temperature, then cured in oven at 300° F for one hour after they had been dried. The cured specimens were placed in water and the absorption and dimensional changes recorded.

WATER ABSORPTION OF WOOD VENEER

	Percent Absorbed 24 hours	Percent Absorbed 72 hours	Percent Absorbed 1 week	Percent Absorbed 2 weeks	Percent Absorbed 4 weeks	Percent Absorbed 10 weeks
A. WATER SOLUBLE PHENOLIC B.R. 5996						
1. Impregnated 15 minutes	39.15%	56.6%	67.8%	77.0%	89.6%	96.4%
2. " 1 hour	38.2%	52.3%	65.9%	74.7%	81.4%	84.0%
3. " 6 hours	31.6%	49.0%	61.8%	70.9%	81.4%	83.2%
4. " 24 hours	26.7%	44.7%	62.4%	73.7%	80.8%	80.6%
B. PHENOLIC RESIN B.V. 14767 C.L.R.						
1. Impregnated 15 minutes	44.8%	61.6%	75.8%	89.8%	104.0%	108.8%
2. " 1 hour	47.7%	63.8%	72.2%	86.0%	106.0%	109.0%
3. " 6 hours	48.4%	63.8%	77.8%	82.3%	96.9%	101.3%
4. " 24 hours	54.9%	67.3%	76.8%	84.0%	95.8%	97.0%
C. PHENOLIC RESIN B.V. 1115						
1. Impregnated 15 minutes	49.7%	66.2%	77.4%	85.7%	101.5%	108.4%
2. " 1 hour	50.3%	65.8%	78.7%	82.4%	100.2%	106.0%
3. " 6 hours	46.7%	60.2%	73.4%	89.2%	98.6%	102.9%
4. " 24 hours	52.0%	65.4%	76.7%	74.9%	94.6%	97.2%
D. WOOD IN ORIGINAL STATE (no impregnation)	49.5%	70.6%	84.2%	93.3%	116.2%	124.0%

20. SURGERY AND COLD CURVED LIGHT
Anon. - Plastics (England), P. 321, Dec. 1941.
A great step in the development of methyl methacrylate surgical instruments is revealed in the announcement by Vann Bros. (London) that the instruments now made by them can be sterilized by boiling, and that prolonged boiling has no effect on the plastic. The ability of this plastic to transmit cold light lengthwise through a solid rod of any curvature is well known, but it is equally well known that this plastic heretofore softened in boiling water or when heated in an oven at 90 to 100 degrees C.

21. COATING PLASTICS WITH METAL
Anon. - Plastics (England), P. 240, Dec. 1941.
[illegible] or coating of plastics parts with metal is increasing in electrical [illegible]ance, a[illegible] to this article which describes practices and [illegible] vogue [illegible] Britain.

22. PLEXIGLAS FABRICA[illegible]
Rohm and Haas Company, [illegible] companies manufacturing [illegible]. Originally prepared for companies manufacturing [illegible] purposes, this 20 [illegible] fabricating Plexiglas for defense purposes, this is the most [illegible] manuals of its kind ever printed. It not only reveals the most [illegible] of machining and forming transparent sheets, but gives formulas and techniques for successful cementing operations. It shows how bullet holes and other fractures can be promptly repaired.

23. INDUSTRIAL PLASTICS by Herbert R. Simonds
Pitman Publishing Co., New York, 385 pages, $4.50.
In this second edition of a popular book published originally more than [illegible] readers right up to the moment in plastics developments and [illegible] the Future of Plastics based upon his personal [illegible] of the industry.

[illegible] WOOD [illegible] with synthetic resins. [illegible] plywood [illegible] in this 16-page booklet [illegible] low-cost training airplanes in mass [illegible] bonded plywood progress to date is [illegible] with [illegible] described [illegible] populat[illegible] of resin-

25. MODERN PLASTICS CATALOG
Breskin Publishing Corporation, New York. 600 pages - $8.00.
The sixth edition of this Catalog of the Plastics Industry has a number of new features which add to its value. There is a comprehensive section devoted to plastics applications in National Defense; a new "WHO'S WHO" in the plastics industry - giving individual names and addresses; expanded sections on synthetic rubbers, fibers, and filaments; and a new chapter on the manufacture and uses of vulcanized fiber. The Properties Chart; Solvents Chart; and Plasticizers Chart all offer much more extensive information than earlier issues.

26. ETHYLCELLULOSE SHEETING IN PACKAGE FABRICATION
F. C. Dulmage, Jr., and T. A. Kauppi
MODERN PACKAGING, P. 88, January 1942.
In this article, [illegible] packaging applications described [illegible] from ethylcellulose [illegible] flexibility, [illegible] Ice cube trays drawn [illegible] low temperature [illegible] lighting reflector

Students at Plastics Institute not only know about current developments in plastics—they have a real part in some of these developments.

These general research projects make significant contributions to the growing knowledge of applications and properties of plastics materials and are carried out under capable supervision as a regular part of Plastics Institute training.

Plastics Trends, published twice monthly, reports general research projects and digests many informative articles from technical and industrial publications. A complimentary copy of Plastics Trends will be sent, on request, to anyone in the industry or to prospective Institute students.

Specific research projects for industry are conducted only by our research staff at Los Angeles.

Plastics
INDUSTRIES TECHNICAL INSTITUTE

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Write for illustrated literature on One Year Engineering, Resident Day or Evening Courses, or Home Study (optional shop training).

We found what an industry lacked for 1100 years

Lacquering is one of the oldest of the industrial arts. By the middle of the last century, it was not only old but decrepit; the 30-coat, three-week finishing process that lacquering required was far too long for industry to tolerate, or for amateurs to bother with.

Then, in 1882, chemists in the Celanese Celluloid organization gave lacquer new life by supplying a solvent that made the process commercially practicable. The solvent is one your nose is always quick to identify: amyl acetate, or "banana oil."

That was in 1882—12 years after this company was launched by the discovery of Celluloid, the world's first plastic, and 45 years before we introduced

LUMARITH

REG. U.S. PAT. OFF.

the new era plastic of today.

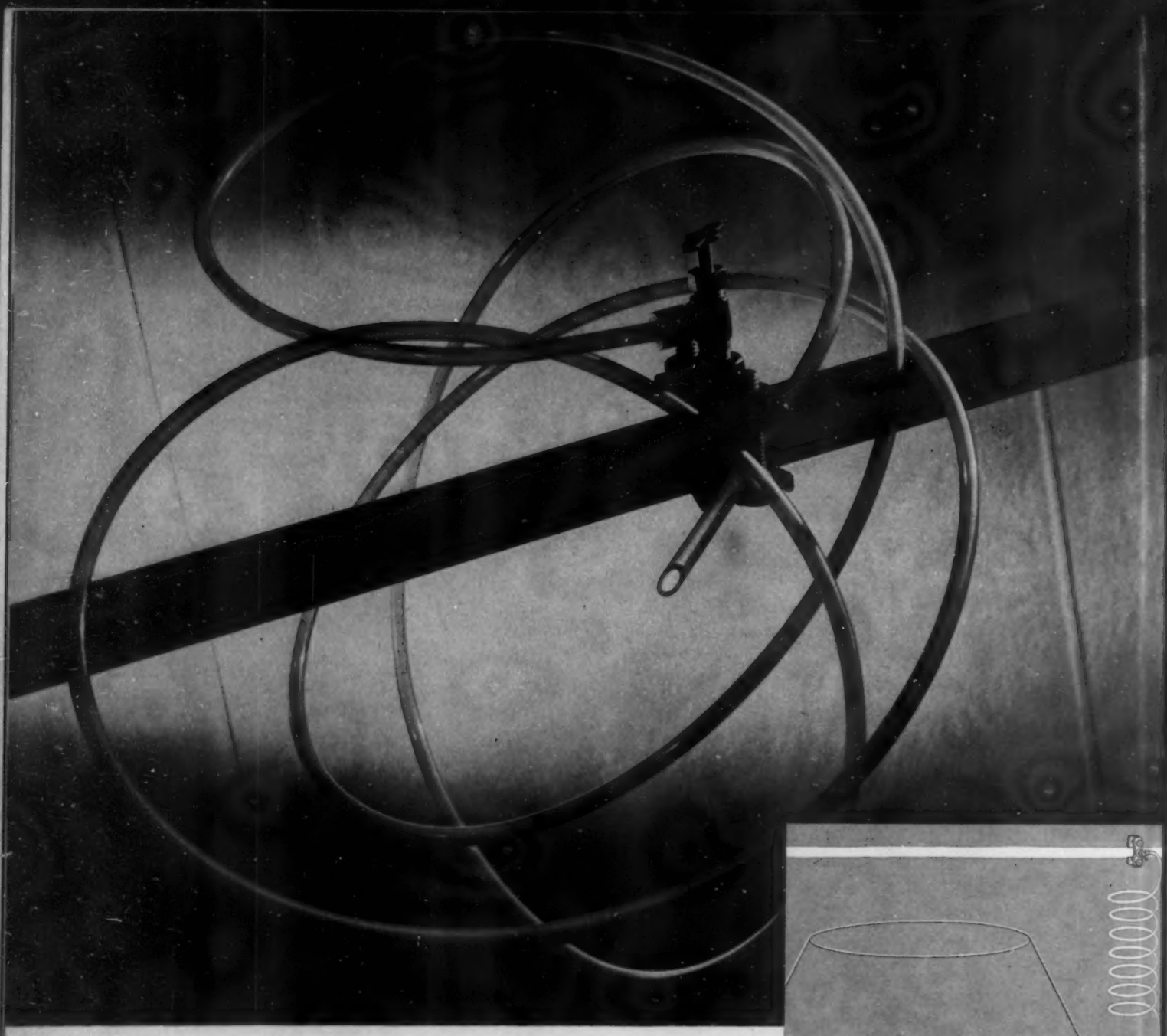
We bring this up as another indication of how the inventive American spirit has a way of solving almost any given problem.

Today, with Lumarith busy on the war front in dozens of different ways, our problem is to find enough material to go around after these vital needs have been met. But solving material problems is our business. With the vigor that got the plastics industry started, we are finding new answers constantly.

All of which leads to this closing suggestion—*to be "in" on new plastics developments, keep in touch with Celanese Celluloid.*

Celanese Celluloid Corporation

Celanese Celluloid Corporation (formerly Celluloid Corporation), 180 Madison Ave., New York City. Sole Producer of Celluloid* (cellulose nitrate), Lumarith* (cellulose acetate), Lumarith Protectoid* (transparent packaging material), H-Scale* (synthetic pearl essence), Lindol* (plasticizer and lubricant additive), Samson* and Safety Samson* Film Bases, and Vimlite* (Flexible health glass). *Trademarks Reg. U. S. Pat. Off.



PIPED THROUGH PLASTIC

Flexible, Durable SARAN Replaces Metal Tubing

Almost simultaneously with the announcement of copper allocations, Dow presented to American industry a flexible, semi-transparent tubing of thermoplastic SARAN* as a replacement for strategic metals. Developed through years of research, this tough, chemically resistant plastic is already being used for applications previously demanding copper, nickel and stainless steel. The job illustrated above is typical of such applications.

Manufacturers using SARAN tubing report highly satisfactory results and state there is no reason for returning to metal even when the emergency ceases. They say SARAN is easier to handle—can be put into position without kinking. It's simple to make a clean cut without special tools, there's no scaling. Furthermore, SARAN tubing can stand repeated freezing and thawing without bursting. It is available in sizes from 1/8" to 3/8" diameter and uses standard fittings.

Perhaps this outstanding plastic material, available also in fine filaments for woven fabrics, indicates some new application to you. For complete information write to the Plastics Sales Division.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York, Chicago, St. Louis, San Francisco, Seattle, Los Angeles, Houston

*Trade Mark Reg. U. S. Pat. Off.

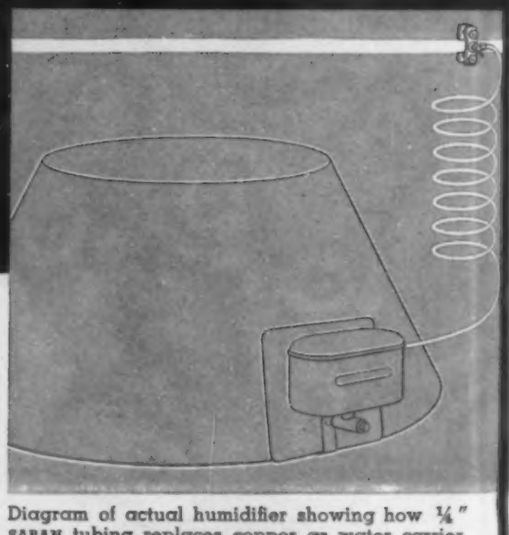


Diagram of actual humidifier showing how 1/4" SARAN tubing replaces copper as water carrier.

SARAN

THE CHEMICALLY RESISTANT PLASTIC

OTHER DOW PLASTICS

★ STYRON ★ ETHOCEL

★ ETHOCEL SHEETING

DOW

PRODUCTS OF CHEMICAL PROGRESS

Less Fatigue • Power Driving • Fewer Operations = 50% Less Assembly Cost with Phillips Screws

It's less work to do more work with Phillips Recessed Head Screws!

Let's analyze that. Phillips Screws cling to the driver — giving the operator one free hand to steady the job. Snug contact between driver and recess means more efficiency — no strength wasted when trying to hold blade driver in slotted head. That's *less work*.

Now: *more work*. Operators have higher output because, with no danger of driver slippage, power drivers can be used in more cases. Fewer operations, too: no pilot holes, no withdrawing crooked screws, no split screw heads, no burrs to file off.

Phillips Screws are saving manufacturers 50% in screwdriving time, which also means: assembling *two* parts for the *price* of *one!*

Write to any of the firms listed below for further facts.

PHILLIPS RECESSED HEAD SCREWS

GIVE YOU 2 for 1 (SPEED AT LOWER COST)

WOOD SCREWS • MACHINE SCREWS • SHEET METAL SCREWS • STOVE BOLTS • SPECIAL THREAD-CUTTING SCREWS • SCREWS WITH LOCK WASHERS

U. S. Patents on Product and Methods Nos. 2,046,343; 2,046,837; 2,046,839; 2,046,840; 2,082,085; 2,084,078; 2,084,079; 2,090,338.
Other Domestic and Foreign Patents Allowed and Pending.

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich.
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The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

This, in case you do not recognize it, is a human ear. We have never been asked to mold one, and sincerely hope the subject never comes up. No one has yet succeeded in reducing it to a few standard sizes, altho we understand the Nazis are making progress along these lines.

We offer it as a symbol.

Maybe we haven't enough material to run all our jobs,

Maybe your job is outlawed by executive ruling,

Undoubtedly you are searching your soul for substitutes to keep your plant running,

Maybe we cannot help you in any way,

BUT—we are always glad to listen to your problems and consult with you, pool our knowledge and experience with yours in seeking a solution, even tho there may be no solution.

It seems to-day as tho our sales engineers have become specialists in listening to other peoples' troubles.

A few years more of these conditions and we all will rename our Sales Departments—call them Listening Posts—a little touch of Military in Industry.

"A Ready Reference for Plastics" written for the layman, is now in a new edition. If you are a user, or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics.

BM CD

BOONTON MOLDING COMPANY

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Forming Plexiglas

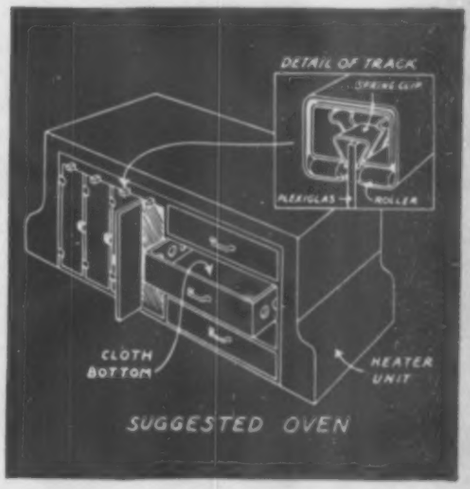
A Rohm & Haas worker demonstrates the proper way to hold the edges of a sheet of PLEXIGLAS against the cloth-covered form.

ROHM & HAAS recently published a booklet that belongs in the hands of every executive and engineer charged with the production of PLEXIGLAS naval, military and aircraft units.

Its name is the PLEXIGLAS *Fabricating Manual.* Its 48 pages contain every important fact on the fabrication and proper handling of crystal-clear PLEXIGLAS.

At this time, when our country needs every PLEXIGLAS unit that it is possible to produce, Rohm & Haas is glad to pass on the benefits of its experience with acrylic plastics. Copies of the new PLEXIGLAS *Fabricating Manual* will be furnished on request.

North America's B-25 bomber is equipped with a PLEXIGLAS nose assembly.



A diagram from the new PLEXIGLAS *Fabricating Manual,* showing an oven which has proved ideal for heating PLEXIGLAS for forming.

THE CRYSTAL-CLEAR ACRYLIC PLASTICS

PLEXIGLAS ☆ **CRYSTALITE**

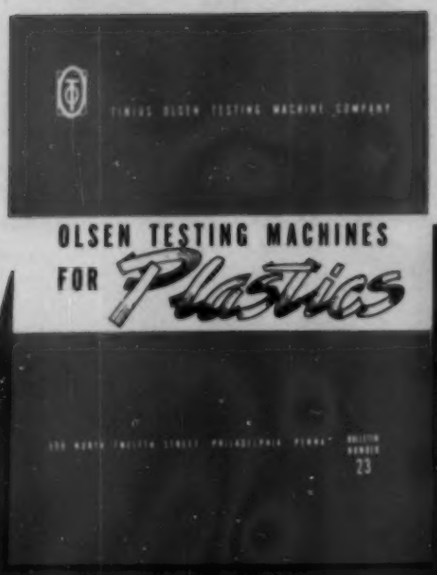
SHEETS AND RODS — MOLDING POWDER

PLEXIGLAS and CRYSTALITE are the trade-marks, Reg. U. S. Pat. Off., for the acrylic resin thermoplastics manufactured by the Rohm & Haas Company.

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Leather and Textile Specialties and Finishes . . Enzymes . . Crystal-Clear Acrylic Plastics . . Synthetic Insecticides . . Fungicides . . and other Industrial Chemicals



THE LAST WORD IN PLASTICS TESTING EQUIPMENT

OLSEN BULLETIN 23

Olsen—a sixty year old Testing Machine manufacturer keeps ahead with one of America's newest and most thriving industries. The publication of Bulletin 23 was withheld for several months while Tinius Olsen Engineers completed final experimental tests on the new Plastiversal pictured below.

Now they are ready to go—the bulletin on the complete line of Olsen Plastics Testing Equipment and the Plastiversal, the first Universal Testing Machine designed entirely around the specifications of the Plastics industry. Be sure to write for your copy of Bulletin 23, today.

"Patented"

TINIUS OLSEN TESTING MACHINE CO.
580 NORTH TWELFTH STREET, PHILADELPHIA, PA.
Western Representative: PACIFIC SCIENTIFIC COMPANY
Los Angeles, San Francisco, Seattle

Proving every day that the value of testing depends on the quality of the testing equipment.

THE LAST WORD IN UNIVERSAL TESTERS

THE NEW OLSEN PLASTIVERSAL*

DESCRIBED IN FULL IN YOUR COPY OF BULLETIN 23

Continental-Diamond

offers laboratory facilities to help you solve "WHAT MATERIAL?" problems . . . C-D manufactures five distinct types of NON-metallic materials . . . DILECTO laminated plastics . . . CELORON molded fabric plastics . . . DIAMOND vulcanized fibre . . . MICABOND mica products and VULCOID laminated resinous fibre. C-D provides facilities for the fabrication of these NON-metallic materials to your specifications, at three strategic points . . . Newark, Delaware . . . Valparaiso, Indiana . . . and Toronto, Canada. Send now for Booklet GF 6A.
Continental Diamond Fibre Company, Newark, Delaware.

* BALTIMORE BOMBER ILLUSTRATION COURTESY OF GLENN L. MARTIN CO.

Vinsol Resin

A POTENTIAL EXTENDER FOR SCARCE MOLDING PHENOLICS

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Properties of this low-cost, available thermoplastic resin indicate its utility in molding compounds.

Today, when plastics is an industry almost entirely surrounded by shortages, ingenuity is at a premium. All raw materials are scrutinized with extreme care, and any opportunity to extend the scarce ones is worth investigation.

The properties of Vinsol* Resin indicate that this material, currently available in very large quantities at an attractive low cost, may provide such an opportunity. Wherever this resinous material is applicable, its indicated ability to extend scarce phenolics 20 to 50 per cent is worth your careful consideration.

Dark in color, hard, with a melting point between 112° and 115°C., and an acid number of 93, Vinsol Resin is a true thermoplastic. It is available as a fine, non-caking powder, in lamellar flakes, or in lump form. Further, since it is partially phenolic in character, Vinsol Resin tends to be compatible with many molding compositions. And, for the same reason, it exhibits tendencies toward condensation with aldehydes. Thus, this low-cost resin can act simply as a hard, high-melting resinous filler and extender, or under certain conditions may enter into the final polymer.

A few companies, after thorough investigation, have discovered ways in which Vinsol Resin can be useful to them. We will supply information on the properties of this resin, and samples for your investigation, upon request (by coupon below or by letter).

*Reg. U. S. Pat. Off.

NAVAL STORES DEPARTMENT
HERCULES POWDER COMPANY
INCORPORATED
968 Market Street, Wilmington, Delaware

GENTLEMEN:
I am interested in Vinsol Resin for _____
☐ Please send information on its properties
☐ Please send a sample for testing

Name _____ Title _____
Company _____
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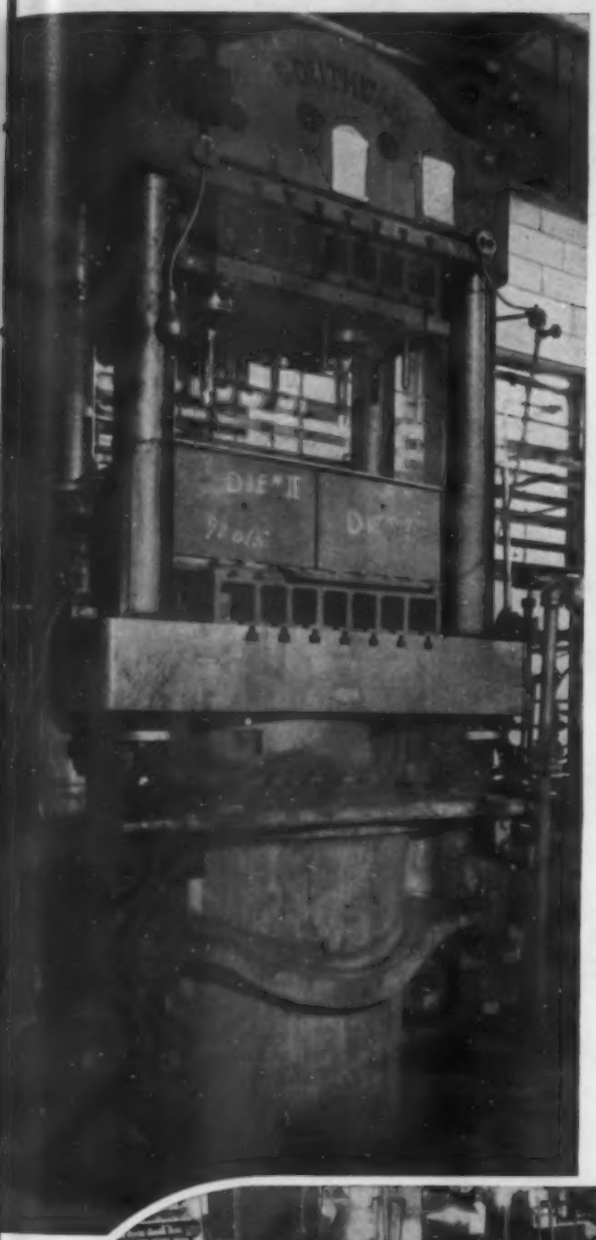
We Are Fully Equipped to Make Your *MOLDED PLASTICS PARTS* for *DEFENSE PRODUCTION*

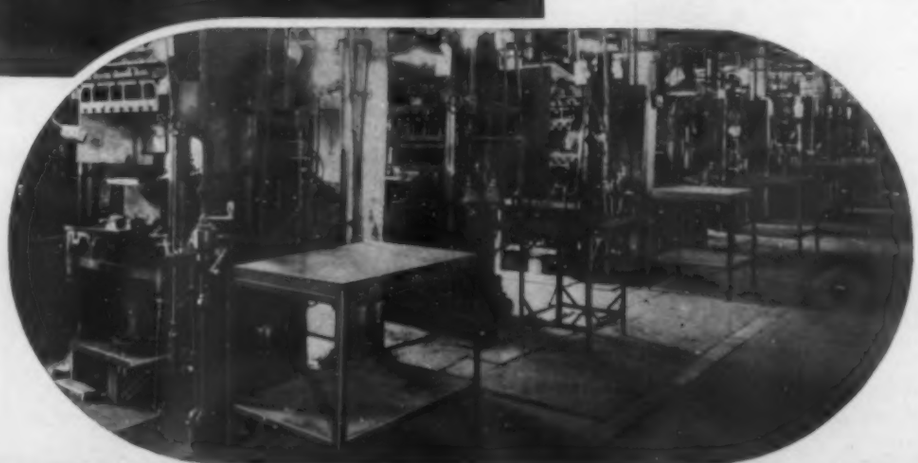


● Here at General Industries we have all it takes to meet your most exacting requirements in molded plastics parts—the capacity, the mechanical equipment, the skill and experience, all backed by an enviable reputation for prompt reliable service.

No matter how large the unit or the quantity required, we can swing into production and prepare to make prompt deliveries.

Our plant with 212,000 square feet of floor space is one of the largest in America. Equipment comprises 128 modern efficient machines of a great range of types and sizes. All operations are under our own roof, from making the molds right through to the finished product.

You can rely on General Industries engineers, long experienced in molded plastics production, to render valuable assistance and cooperate with your departments to the fullest extent.



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The GENERAL INDUSTRIES Co.

MOLDED PLASTICS DIVISION . . . ELYRIA, OHIO

Can You Use a Material with THESE *Characteristics?*

Here is a list of useful qualities all of which are found in combination in Formica:

- Low Moisture Absorption
- Low coefficient of thermal Expansion
- Stability of dimensions under a wide range of conditions
- High mechanical strength
- Chemical inertness—no corrosion
- Non-Porous—non-absorbent
- High dielectric strength
- High insulation resistance
- Low Power factor
- Low hysteresis losses
- Minimum cold flow
- Easily Machinable
- Can be molded in simple forms
- Half the Weight of Aluminum

THAT is an impressive list to be found in one material. Formica has them all and the great and steady increase in the use of the material is based on them. Hundreds of industries have found a use for the material.

Formica is made in three fundamental forms: Sheets, Tubes and Rods from which a great variety of parts can be machined. It is also more and more being molded in simple forms. Send your blue prints for an opinion as to whether the material will serve your purposes

The Formica Insulation Company
4763 Spring Grove Ave., Cincinnati, Ohio

This shows how Formica is built up of laminations of cloth or fibre impregnated with phenolic resins and cured under heat and pressure.

FORMICA

Engineered Specialties

FORMICA maintains a large engineering and research organization and has built its business to a considerable degree on special products into which much engineering has entered. It is always searching for new products of this type. Formica engineers will be glad to advise on your problems. Write direct to the factory.

Now Ready!

140 PAGE FASTENING DATA BOOK

Tells how Shakeproof Products speed up production!

Contains special section on Government approvals!

Explains facilities for volume production of intricate, precision stampings!

Gives full dimensional data on all Shakeproof fastenings!

COMPLETE INFORMATION ON ALL SHAKEPROOF PRODUCTS INCLUDING:

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The new Shakeproof Catalog is now ready for distribution to design engineers, purchasing executives and production men. It presents the complete line of Shakeproof fastenings and other important products with full explanation of types and sizes offered and detailed engineering data. Every metal product manufacturer should keep a copy handy for it is an outstanding reference book which will help solve many important production problems and point the way to faster assembly operations. Send the coupon below for your copy today!

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Please forward my copy of your new Shakeproof Catalog No. 42!

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LET'S WORK THIS OUT TOGETHER

Today, there's a great deal of confused thinking about plastics. Shortages and priorities have upset or are about to upset manufacturing routine —have caused a wild scramble for replacements—have focused attention on plastics as never before.

Plastics are not the magic answer to all the problems. In some cases plastics can do the job better—in other cases it would be foolish to use them. And if plastics are indicated, experienced judgment must be used to give you the right solution—the first time. Don't rush into plastics blindly.

During this state of emergency, we will gladly make available to you our over 65 years of molding experience. If you feel you have a good reason for using plastics, get in touch with us at once. Our engineers will analyze your problems and study possible solutions. Our impartial recommendations are based on unequalled experience and superb manufacturing facilities.

For years we've enjoyed a reputation for cracking "tough" ones. If we say it can be done, we can do it.

Since 1876—

AUBURN BUTTON WORKS, INC.
AUBURN, N. Y.

Custom Molders of

BAKELITE	LUCITE	PLASTECELE
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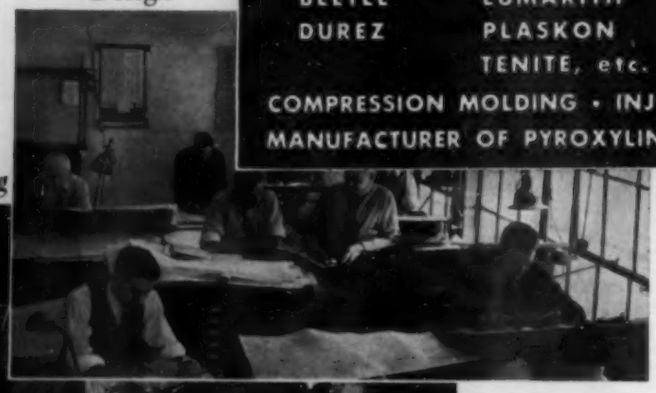
COMPRESSION MOLDING • INJECTION MOLDING
MANUFACTURER OF PYROXYLIN SHEETS & RODS

Design



Mold Making

Finishing

Tough plastics for tough jobs

Handles for Millers Falls tools molded by Worcester Moulding Plastics Company, Worcester, Mass.

COMBINE MANY ADVANTAGES FOR YOUR PRODUCTS

Good workmen are proud of these modern tools with handsome, pleasant-feeling handles that can take it.

DURABILITY, toughness, ease of fabrication, and permanent finish . . . there you have four good reasons why tool manufacturers turn to cellulose acetate plastic.

These same reasons prompt its choice for building and automobile hardware, switch plates, handles, control knobs, and thousands of useful and attractive things—many of them formerly made of metals that now are scarce.

ECONOMICAL, TOO: Cellulose acetate is easy to mold on the fastest automatic machines. Scrap can be reworked. Finishing costs are saved, because any color can be built right into the material. It is light in weight, resistant to many destructive agents, and high in dielectric strength.

Hercules' part in all this is to make cellulose acetate flake of exceptional quality. Hercules can do this because of long research and unusual manufacturing skill developed in producing cellulose derivatives. You can get the benefit of this experience and skill by specifying that your plastic articles be made from compounds containing Hercules Cellulose Acetate Flake.

Write for a booklet about Hercules Cellulose Acetate. Address Department MP-2. DOD-45

HERCULES

CELLULOSE ACETATE

HERCULES POWDER COMPANY *Incorporated* **· WILMINGTON, DELAWARE**

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Behind PRODUCTION *Stands Press* PERFORMANCE

Increased requirements for plastic molded articles call for presses *rugged* enough to stand production demands placed upon them, *accurate* in performance to maintain highest quality, and *economical* in operation and maintenance so that unit cost can be kept low.

Southwark hydraulic plastics molding presses have proven their reliability, have shown the way to reduced production costs, have helped many a company do a better job — more economically.

Baldwin Southwark Division of The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.

Baldwin Southwark

DIVISION OF THE BALDWIN LOCOMOTIVE WORKS

PHILADELPHIA

BLW THE BALDWIN GROUP

TO THE Hilt

PLASTICS are in this war, up to the hilt. Nixon plastics are going into key items of National Defense, as well as essential civilian production.

These are the facts. The next move will come from the Government, and neither we nor they know what it will be. They may take more of our plastic materials. They may utilize our equipment, organization and plant for an even more essential purpose.

We have enlisted for the duration. That is our policy and that will be our policy as long as the Government needs our services.

NIXON PLASTICS

NIXON NITRATION WORKS, INC.
Mfrs: NIXON ACETATE MOLDING POWDERS • NIXONITE (acetate) and NIXONOID (nitrate) sheets, rods, tubes
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"O-I Plastics reflect . . . *the experience and resources of the developers of Duraglas containers . . . The World's Finest*"

Why they asked US to *"custom mold"* their Inhalers

Like many others, these manufacturers felt the need for an organization—with its own Plastics Research Laboratory, a corps of plastic design-engineers, its own mold-making shops—plus up-to-date equipment and a wide background of actual molding experience.

All these they found in the Owens-Illinois Plastics Division. They found, too, that their job started right and went through to delivery of the finished product under strict "quality control." These are the exceptional facilities we offer *you*—whether your molded item calls for a run of thousands, millions, or multi-millions.

We operate 4 modern plants—in Glassboro, N. J.; Gas City, Ind.; Toledo, Ohio; San Francisco, Calif. *We are completely equipped for . . . automatic rotary compression molding; injection molding; upright compression molding; printing on plastics; metal plating of plastics.*

Some of the *"custom-molded"* items we have made

Plastics Division...OWENS-ILLINOIS
TOLEDO OHIO

A Vital Ray of Light

WHEN THE "ALL CLEAR" SIGNAL SOUNDS

The Changeover to
NATIONAL VULCANIZED FIBRE
Releases Essential Plastics for Defense
Keeps production of Flashlights moving for the Home Front

★ ★ ★

A well-known manufacturer of flashlights was confronted with shortages of certain plastics which were used as insulating parts. The problem was to find a replacement material which would do the job just as well. The answer was found in National Vulcanized Fibre because of its excellent electrical insulating qualities and its ready fabrication into many forms and shapes.

Today, National Vulcanized Fibre is finding more and more uses in industry as a practical replacement material for hard-to-get metals and plastics. Our engineering and research facilities are available to you on any problem. Wire, phone or write us.

You can use this Handbook profitably. Write for free copy today.

NATIONAL VULCANIZED FIBRE COMPANY
WILMINGTON DELAWARE
Offices in Principal Cities

★ ★ ★ *Broadening American Enterprise through Dependable Plastics* ★ ★ ★

Sandpaper Can Smooth Wrinkled Foreheads, Too

The finishing of plastics; removing fins and flashes; truing and cleaning holes and other almost inaccessible places; smoothing concave sections; many of these jobs can only—or best—be done with Coated Abrasives in the correct mineral coating, grit, backing and shape.

For your help on puzzling jobs that may be confronting you, we offer the free services of trained, experienced Field Engineers.

By means of little discs, cones, tubes and other ingenious abrasive forms which we are constantly developing, they can very likely short-cut many of your finishing operations and produce a finer result.

Why not let us help? Simply get in touch with our nearest branch. *We can't win unless you do.*

RELIABLE COATED ABRASIVES SINCE 1872

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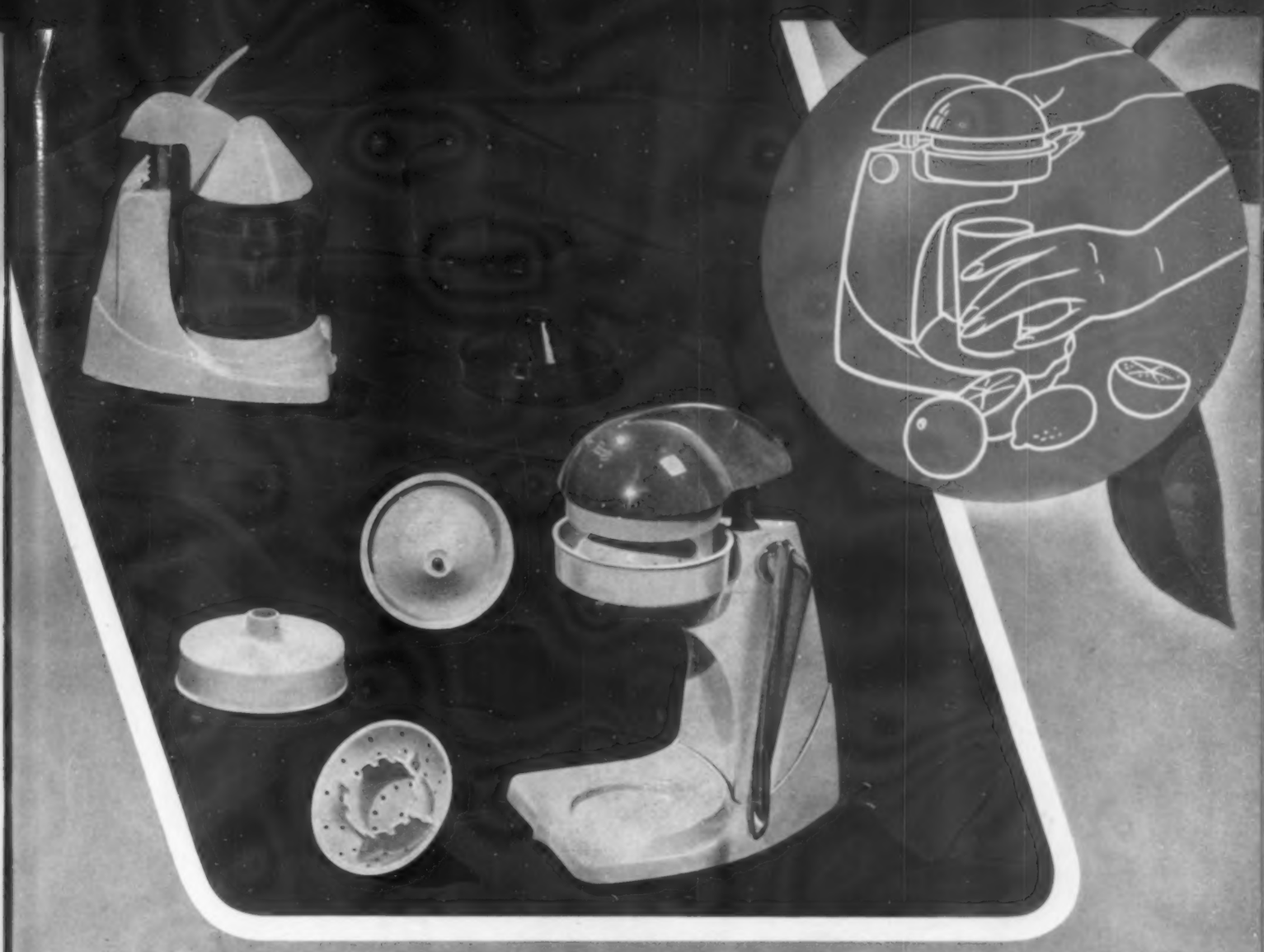


The "A-B-C's" of Plastics may be interpreted as Adaptability, Beauty and Color. These fruit juicers use plastics to replace metals and have the advantages of strength, color and eye-appeal to cash in by product improvements. This is one of many instances where we have been able to adapt plastics for increased utility and sales value. We may be able to help you. Our engineers are at your service . . . no obligation, of course. Ask for information.

Your signature on your letterhead brings you a copy of this catalog containing data and illustrations of molded thermoplastics.

ELMER E. MILLS CORPORATION

Molders of Tenite, Lumarith, Plastacele, Fibestos, Lucite, Crystallite, Polystyrene, Styron, Lustron, Loalin, Vinylite, Mills-Plastic, Saran and other Thermoplastic materials.

812 WEST VAN BUREN STREET • CHICAGO, ILLINOIS

Mold Automatically

NEW AND IMPROVED

Completely Automatic Machines

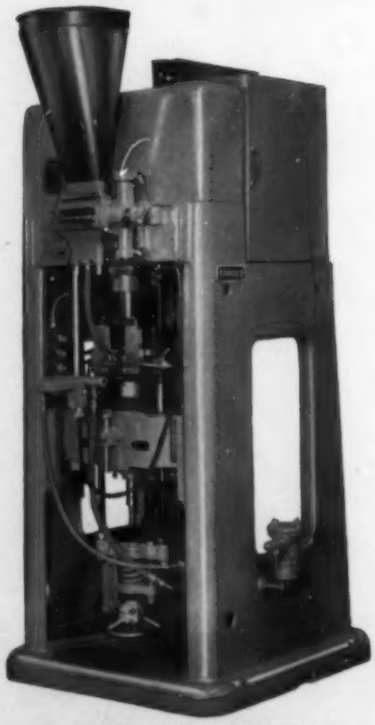
Availabie in Limited Quantities for Prompt Delivery

Automatic Molding is the answer to many of today's production problems. It produces parts of highest quality and almost absolute uniformity . . . moldings that meet the most exacting Navy and Army specifications.

It enables you to get into production faster . . . with molds having fewer cavities, that are made quicker, at lower cost . . . and to obtain higher daily output per cavity.

New Automatic Machines are improved, more productive, more efficient. They handle a wider range of molding powders, including "semi-impact" materials . . . are more rapidly set up and changed over . . . incorporate many new design features.

Automatic Machines are producing millions of Army and Navy moldings with total rejects less than 3%. They are saving material, 8% to 10% or more, with flash losses less than 1% on some operations.



Patented — U. S. and Abroad

They are increasing labor output, one man operates an entire battery of these machines. They are saving molding time, every possible second . . . cycles are reduced 50% or more in many cases . . . output per cavity is increased in proportion. Production is continuous, 24 hours per day and 7 days a week.

If you need moldings, better moldings, quickly, new Automatic Machines now in manufacture and soon ready for delivery may be your answer. Consult with us.

F. J. STOKES MACHINE COMPANY

5934 Tabor Road Olney P. O. Philadelphia, Pa.

Representatives in New York, Chicago, Cincinnati, St. Louis, Cleveland, Detroit

Pacific Coast Representative: L. H. Butcher Co., Inc.

F.J.Stokes MOLDING EQUIPMENT

FJS Est. 1895

"It gives me pleasure to advise you that your organization has been chosen to receive the flag of the Bureau of Ordnance and the Navy 'E' pennant in recognition of your outstanding efforts in the production of ordnance materiel vital to our national defense. Recent events have made this award of even deeper significance than any which have been made in the past."

Secretary of the Navy Frank Knox, in a letter to Monsanto.

"E" stands for teamwork!

Among the crews of Uncle Sam's warships and naval planes, the Navy "E" is one of the most coveted and respected honors the men of a single gun turret or an entire battleship can win.

It is a symbol, not of individual brilliance, but of championship teamwork . . . teamwork that only long, gruelling hours of actual practice could perfect.

The same tradition governs the award of a Navy "E" to an industrial plant.

The "outstanding jobs" which win an Ordnance Bureau flag and "E" pennant are not the work of one brilliant "lone wolf" in the research department—or a single, capable executive. They are the result of teamwork that only starts with the quarterback in the front office and includes every man in the organization to the policeman on the plant gate . . . teamwork that only long years in the peacetime service of industry could perfect to the peak of efficiency demanded by a nation at war!

Monsanto is proud to fly the Navy "E" in recognition of past performance . . . glad to accept the responsibility it imposes for future performance. MONSANTO CHEMICAL COMPANY, PLASTICS DIVISION, SPRINGFIELD, MASSACHUSETTS.

MONSANTO PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

2½ ACRES DEVOTED TO PLASTICS for VICTORY

For instant action on your war production job in plastics, phone us at Chicago, CAPitol 1020. A member of our engineering staff, fully qualified to help you with any government work involving molded plastics, will be sent to you immediately, anywhere in the United States.

CHICAGO MOLDED PRODUCTS CORP.

1046 NORTH KOLMAR AVENUE CHICAGO, ILLINOIS

Unlimited Speed

IS THE ONLY ANSWER TO "PEARL HARBOR"

WE ARE READY

to meet the demand for Conduit Clamps either plain or with SPEED NUTS attached.

The Fastest Thing in Fastenings

SPEED is the essence today. And SPEED NUTS are unexcelled in assembly speed. As illustrated, our new AC-755 type tube clamp, with self-retaining SPEED NUT attached, requires only the use of a screw driver to assemble. It instantly grips the screw with a double spring tension lock to prevent vibration loosening. The assembly is simplified, time is saved and weight reduced. For complete information on sizes and types, write for bulletin No. 148-2.

This is only one of hundreds of SPEED NUTS and SPEED CLIPS that are cutting aircraft assembly time to a new low.

Let the speed of the SPEED NUT SYSTEM help roll those planes out faster every month, and lower your net costs wherever SPEED NUTS are used. Send us your assembly details and we will mail you samples and engineering data promptly.

TINNERMAN PRODUCTS, INC. 2048 FULTON ROAD CLEVELAND, OHIO

MANUFACTURERS OF PATENTED SPEED NUTS

IN CANADA: Wallace Barnes Co., Ltd., Hamilton, Ontario

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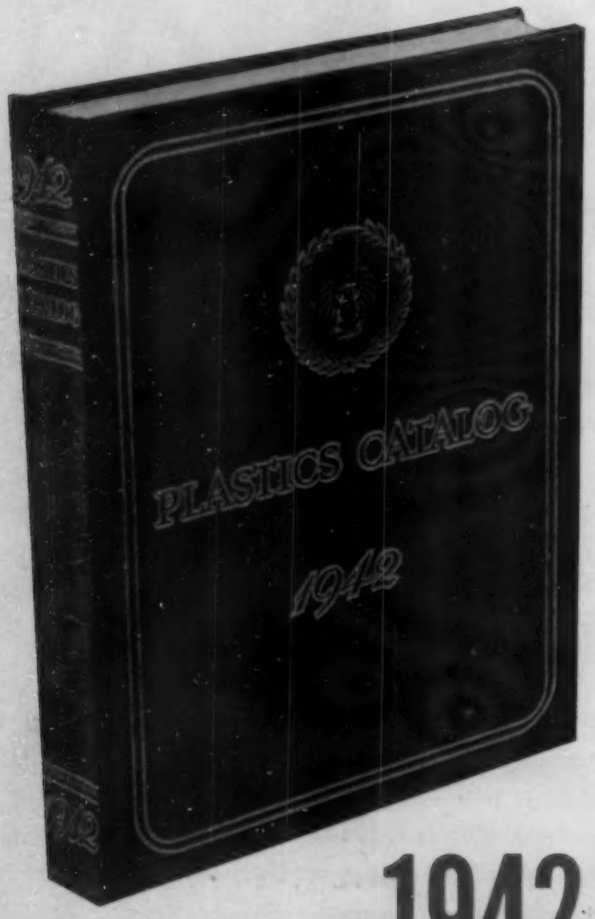
Accelerates Assembly **Speed Nut System** (PATENTED) Lowers Net Costs

OVER A BILLION IN USE ★ ★ OVER 1,000 SHAPES AND SIZES

THIS BOOK WILL SOON BE A COLLECTOR'S ITEM



AN unprecedented wave of advance sale has all but consumed the largest printing of the Plastics Catalog. The 1942 edition of 10,000 copies is almost completely sold out.

This is the only complete and up-to-date sourcebook and handbook of reliable, authoritative information on plastics. It contains separate articles on every commercial plastic material, every commercial method of manufacture. It contains flow sheets and charts of physical, chemical and electrical properties of each plastic. There are also complete properties charts of solvents and plasticizers used in the plastics industry.

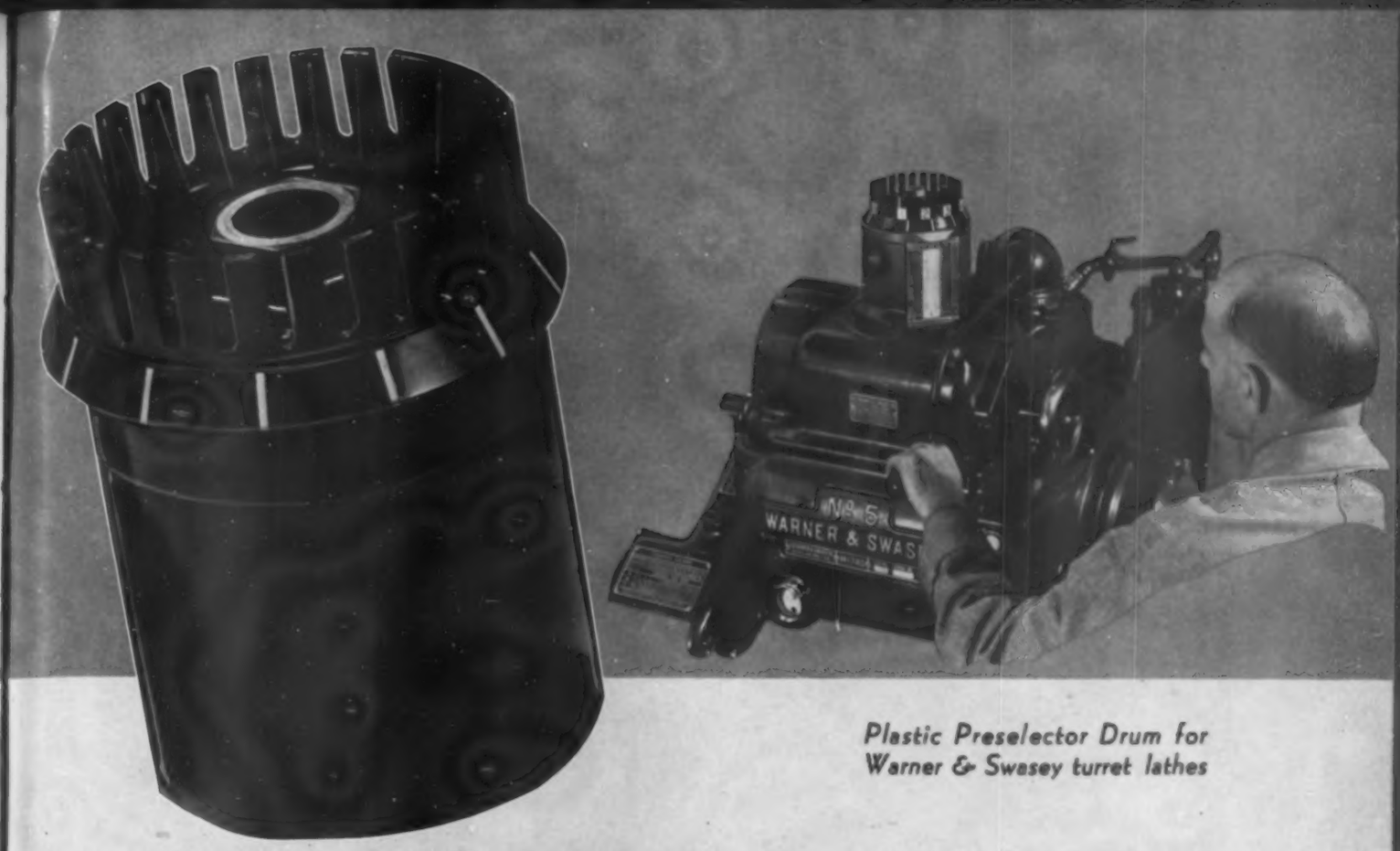
Its 624 pages include the only complete directory to plastics manufacturers and suppliers, as well as a bibliography, nomenclature and index of molders' marks.

To those individuals and firms who have neglected to order copies, and to subscribers who wish additional copies, this announcement is made. A few copies of the 1942 Plastics Catalog are in stock—orders can still be filled—but once the present supply is exhausted there will be no more Catalogs until the 1943 edition. Order now!

Price: $5.00 per copy
Foreign & Canadian, $6.00

1942 PLASTICS CATALOG

122 East 42nd Street, New York City



Plastic Preselector Drum for Warner & Swasey turret lathes

THERE'S NO PRIORITY ON *Ingenuity*

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To save 1400 pounds of aluminum per month, The Warner & Swasey Co. turned to plastics in the manufacture of their Preselector Dial Drums. Not only do they conserve aluminum needed so urgently for Defense, but they save 80% in manufacturing costs for this part. To make this saving, they came to Reynolds. Let Reynolds show you how you can also save.

REYNOLDS MOLDED PLASTICS

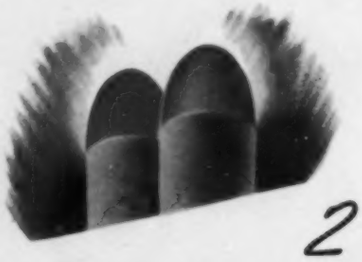
CAMBRIDGE, OHIO, U. S. A.

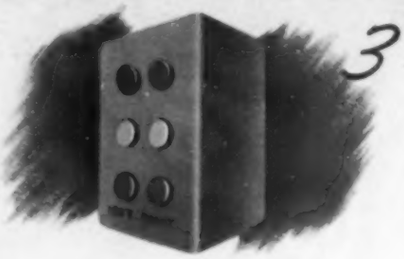
DIVISION: REYNOLDS SPRING COMPANY • JACKSON, MICHIGAN, U. S. A.

THERE ARE MANY NEW AND TIMELY JOBS PLASTICS CAN DO!

Illuminated, highly visible instrument housings and parts of Beetle... unaffected by oils, gases, cleaners.

Identifying colors for signal and warning light shields in translucent Beetle.

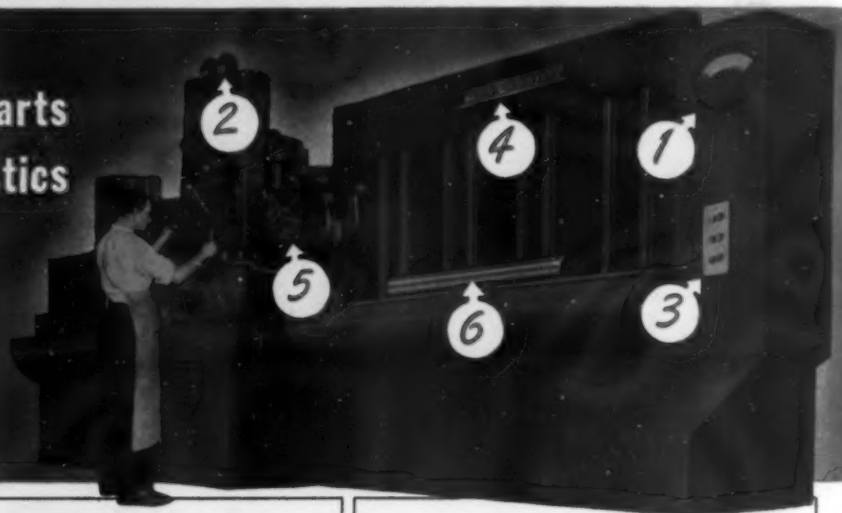




High dielectric strength and arc resistant electrical controls of Melmac 494... colored buttons of Beetle.

Machinery and Machine Tool Parts Made of Beetle and Melmac Plastics

MAY SIMPLIFY DESIGN . . . SPEED PRODUCTION . . . GIVE IMPROVED EFFICIENCY and PERFORMANCE



Illuminated translucent direction, warning or nameplate signs of fluorescent laminated Melmac.

Electrical insulating and thermally non-conducting handles in identifying colors of Beetle.

Excellent light transmission and light diffusion with protective sheets of translucent Melmac.

Many machine tool and machinery parts are being "standardized" to speed their output and increase manufacturing efficiency and economy! And the inherent advantages of BEETLE* and MELMAC* can aid design, speed production, and improve performance of many of these parts!

Shown here are a few parts and accessory items which might be produced in one or the other of these materials.

The physical and electrical properties of these plastics suggest their use with resultant advantages over materials now employed—plus new speed and economy of production.

For example, BEETLE offers identifying color, translucence, electrical and thermal insulation. In addition to these, MELMAC 494, a new plastic developed by Cyanamid research, gives extremely high dielectric strength (60 Cycles—382-403 volts/mil at 100° C.), high arc resistance (145), and a resistance to elevated temperatures, which immediately suggest its use for many power and control applications. Both materials are light in weight, durable, and resistant to oils, grease, common solvents. Let us send you full information on these two plastics.

AMERICAN CYANAMID COMPANY

Plastics Division

30 Rockefeller Plaza • New York, N. Y.

**Reg. U. S. Pat. Off.*

Beetle and Melmac

CYANAMID PLASTICS

How to find out if you can use plastics to advantage

Complete technical data on BEETLE and MELMAC is given in our literature—available on request. If you have a specific application in mind, our engineering or service department may know the answer from previous investigation of a similar problem. In addition, our Stamford Research Laboratories are available for experimental work on new applications.

MODERN PLASTICS
FEBRUARY 1942 VOLUME 19 NUMBER 6

Walnut shell flour

by E. F. LOUGEE*

IF Mr. D. V. Sickman hadn't gone to Los Angeles for a vacation in 1929, manufacturers of plastics, rubber, insecticides, dynamite, carbon and dozens of other items might never have known the advantages which walnut shell flour brings to their products. That was when Mr. Sickman became interested in finding a place in industry for waste walnut shells and began studying their possibilities.

Plastics derive a number of benefits through the use of walnut shell flour as a filler. Molded parts have an exceptionally smooth, lustrous finish; have higher resistance to moisture and heat, high dielectric strength and require less resin to bind the compound. The chemical composition of walnut shells is shown in Table I. These shells do not decompose when exposed to the elements. They remain hard and show no deterioration even when buried deep in the earth for years.

It will be noted that cutin, varying from 1.7 to 6.3 percent, is present in the make-up of walnut shells as well as a relatively high lignin content. Cutin is a wax which serves practically to waterproof the walnut shell. When the shell is crushed and ground, the cutin remains unimpaired, with the result that the filler does not absorb so much resin in the manufacture of molding compounds. Walnut shells have high *adsorption* but are almost entirely *nonabsorbent*. The lignin in walnut shell flour, which is a good binder in its own right, also acts as an extender further to reduce the quantity of resin required. This means that molding compounds can carry a greater proportion of filler without lessening their mechanical strength. A lower specific gravity and lower cost are the result.

Cutin is also found in the bark of trees and stems of plants. It is nature's way of preventing moisture evaporation. It is not present in wood; therefore there is no cutin in wood-flour. The amount of cutin in walnut shells varies according to the grade of shells used. Twenty-six different kinds of walnut shells are ground into fillers of various grades each year.

* Plastics Industries Technical Institute.

The actual development of commercial uses of walnut shell flour started in 1933 after Mr. Sickman had carried on more than three years of experimental research for the California Walnut Growers Association. In April of 1935 this Associa-

TABLE I. CHEMICAL COMPOSITION OF WALNUT SHELLS

Dry Analysis

	Percent
Cellulose	59.6 to 60
Lignin plus cutin	32.3 to 33.8
Cutin	1.7 to 6.3
Lignin (by deducting the cutin)	26.0 to 32.1
Furfural	5.20 to 5.44
Furfural, calculated as pentosan	8.88 to 9.27
Methoxyl	6.30 to 6.51
Nitrogen	0.1
Total sugars, calculated as glucose	0.20 to 0.35
Ash	0.38 to 0.53

Solubility

	Percent
Cold water solubility	1.0 to 1.5
Hot water solubility	2.21 to 2.55
One percent NaOH	13.1 to 14.8
Ether	0.16 to 0.28
Alcohol—benzene	2.10 to 2.49
Alcohol (95% for 4 hrs.)	2.30 to 2.56
Alcohol (80% for 9 hrs.)	2.87 to 3.25

General Notes

The cutin content is, on the average, about 5 percent.

The fact that 33.8 to 39 percent of this material is not dissolved in concentrated sulfuric acid (72%) is of importance in a number of applications.

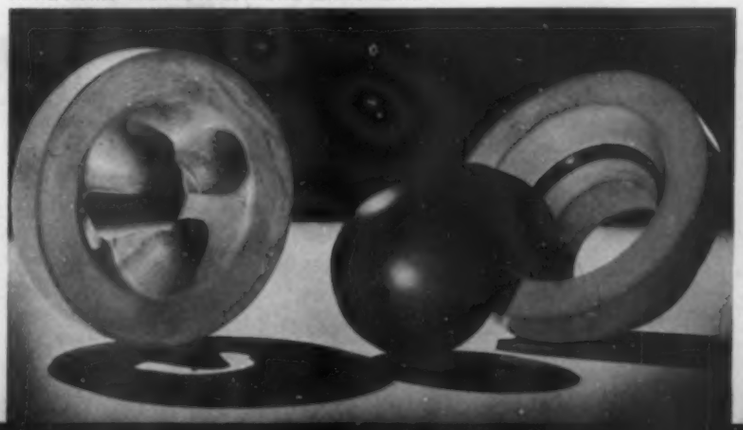
The ash (0.38 to 0.53%) contains calcium, potassium, phosphorus and magnesium.

Specific gravity: 1.35 to 1.45.

Weight of fine mesh walnut shell flour: 29 to 31 lbs./cu. ft.

***1**—Twenty-five to 30 percent walnut shell flour filler is used in this back pressure ball valve casting for oil-well operation. Bumper fingers are cast into the base (left) and a rubber ring into the top (right). The ball (center) is molded phenolic.* ***2**—Large meter block of molded walnut shell flour filled phenolic*

PHOTOS, COURTESY BAKER OIL TOOLS, INC., AND GENERAL ELECTRIC CO.



PHOTO, COURTESY GENERAL ELECTRIC CO

3—Switch section (left) is molded of walnut shell flour filled phenolic. 4—On the opposite page, the miniature radio cabinet housing (top) was cast in the 4-piece mold (center and bottom) made of walnut shell flour filled cast resin

tion, through its Control Board, authorized the expenditure of $25,000 for the erection of a pilot walnut shell grinding plant, and the plant was put into operation in August of that same year.

Prior to 1935, about the only use made of walnut shells was for chicken feed carbons but this took only a small portion of the everyday waste product of shells from the cracking plants. It had been demonstrated in laboratory tests that by pressing walnut shell flour, slightly moistened with water, at the same temperatures and pressures used for molding phenolic plastics, the material would bind itself back into a hard mass. The high lignin content in the shells was released at these temperatures and pressures, and the addition of very little resin was needed to make an acceptable molded product. Samples of molded parts in which 95 percent was filler showed remarkable mechanical strength.

Shortly after the pilot plant began operating, a real problem arose when Agicide Laboratories of Milwaukee ordered 2000 tons of flour to go into insecticides as a carrier. That represented more than twice the capacity of the pilot plant for a year, so after some little negotiation Agicide bought and enlarged the mill. This company now has a long-term contract with the California Walnut Growers Association to take all the walnut shells they produce.

About 4000 tons a year are ground into flour; the rest are sold to other manufacturers and used as a filler for dynamite, and carbon for gas masks. Of the 4000 tons of walnut shell flour, about half goes into the plastics industry, about one-fourth goes into insecticides and the remaining fourth is consumed by industry in widely separated fields. All excess shells have been requisitioned by the Government recently for making gas mask carbon. Approximately 18,000 tons are available this year over and above the amount required for grinding into flour.

When the shells come from the growers, there is always a small percentage of nut meats in them which has to be removed. This is done in another plant where oil is extracted from meats and shells crushed. They then pass through a drier where most of the remaining nut meats are incinerated. There is no oil in the walnut shell itself and the nut meat oil which remains in the shells when they are ground probably amounts to only $1/4$ to $1/2$ of one percent. This nut meat oil contains eight acid-type glycerides, so walnut shells are slightly acid in reaction. They have a pH of about 6 or $6\,1/2$, just under the borderline between acidity and alkalinity.

Mills used for grinding the shells produce spherical particles of uniform shape and size. Meticulous care is exercised in screening and grading walnut shell flour so that uniformity may be depended upon. This point is confirmed by W. Goss, Plastics Laboratory, General Electric Co.

In commenting further upon the use of walnut shell flour, Mr. Goss says: "We use a certain percentage of walnut shell flour as a filler in some of our compounds. The walnut shell flour has a low absorption as compared with wood-flour and, therefore, increases the effect of the resin in a compound or acts more on the order of an extender in that it requires less resin because of the lower absorption. When the usual amount of resin required for wood flour is used with an all walnut shell flour filled compound, the resulting compound is usually very soft, and the molded article has an exceptionally smooth, glossy finish. The mechanical strength of walnut shell flour filled compound is often equal to that of wood-flour filled as far as flexural and impact resistance are concerned, but remarkably decreased as far as tensile and compressive strength are concerned. So much so as to limit its use considerably. We often use both types of filler together in order to obtain the most benefit from the material."

Mr. Goss sums up the advantages and disadvantages of walnut shell flour filler as follows: "It has great advantage in that the specific gravity is low and the absorption is low.

TABLE II. A CHART OF COMPARATIVE AMOUNTS OF DIFFERENT FILLERS GIVING APPROXIMATELY THE SAME PHYSICAL STRENGTHS

Type of filler		Filler, percent	Resin and catalyst, percent	Physical strengths		
				Yield point compression	Tensile strength	Impact strength
Walnut shell flour	D-50	35	65	Slightly above that of pure resin	10% lower than pure resin	10% lower than pure resin
Walnut shell flour	100 mesh	25	75	Slightly above that of pure resin	25% lower than pure resin	10% lower than pure resin
Walnut shell flour	12–20	40	60	Inferior to that of pure resin	40% lower than pure resin	50% lower than pure resin
Balsa wood flour	−20 mesh	3.5	96.5	Slightly above that of pure resin	30% lower than pure resin	40% lower than pure resin
Wood-flour	20 mesh	12.2	87.7	Slightly above that of pure resin	30% lower than pure resin	10% lower than pure resin

NOTE: The physical test figures vary as much as 10% in sets of duplicate samples. These tests were conducted jointly by Dr. K. J. Leeg and J. R. Baker of Baker Oil Tools, Inc.

The disadvantages are the little fiber in walnut shell flour to produce strong bonds and the expense involved in transportation across the country."

Increasing quantities of walnut shell flour are being used in casting resins for industrial purposes, especially in the aircraft industry where casting resin is being used in place of metal for forming dies. Many such molds have been made in the past few months and they are rapidly increasing in size. Some of the recent molds weigh 200 to 300 lbs. At least one of them weighs 500 lbs.

The industrial use of casting resin filled with walnut shell flour was initiated by Baker Oil Tools, Inc.* during the past year when they created a new casting phenolic resin to make guide shoes for oil well equipment. The use of cast resin forming dies in the aircraft industry is an outgrowth of this development.

"The particular advantages of walnut shell flour over wood-flour as a filler for cast resin," says Dr. K. J. Leeg, Plastics Division of Baker Oil Tools, Inc., "are primarily monetary advantages. As a general rule, walnut shell flour will not do anything that wood-flour will not do, but a great deal more walnut shell flour can be used without any greater loss in physical strength. For example, about twice as much or more walnut shell flour than wood-flour can be used with a decrease of 10 percent in compression. There is a certain amount of variation in this, depending upon the grade of filling material used, and on the particular physical strength desired. [See Table II.] Another specific advantage of the walnut shell flour over the wood-flour is the fact that the resultant walnut shell flour filled plastic is more heat resistant.

"We have found that the walnut shell flour specified as D-50 by the Agicide Laboratories is the best grade for general use. D-50 is a walnut shell flour aggregate. Part of the material is approximately 40 mesh, and it goes down in size steadily to a fair quantity that is sub-sieve. As a general rule, the finer the particle size of the walnut shell flour, the greater the decrease of the physical strength of the mix for a given weight. For this reason, less walnut shell flour can be used in the fine grades than in the coarser grades. For example, it is difficult to use more than 15 percent of −325 mesh walnut shell flour. Better than 25 per cent −100 mesh can be used, and 35–40 percent of D-50 can be used. The 12–20 walnut shell flour can be used to as high as 50 percent by weight for a few special purposes. The extremely coarse walnut shell flour is not generally satisfactory because the product is too heterogeneous and is inclined to be weak across the lines of demarcation."

It should be understood that any differences in the evaluation of wood-flour and walnut shell flour fillers which appear in the statements of Mr. Goss and Dr. Leeg are traceable to a natural difference in their points of view. Mr. Goss's comments refer to his experiences with walnut shell flour as a filler for molding compounds, while Dr. Leeg refers to its use only in casting resins. The (*Please turn to page 100*)

PHOTO, COURTESY PLASTICS INDUSTRIES TECHNICAL INSTITUTE

* MODERN PLASTICS, *19*, No. 2, Oct. 1941, p. 48.

Dressing table jewels

A new trend is indicated by heavy section injection molding of colorful brush backs

1

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THE appearance on the market some 18 months ago of a line of colorful acrylic hairbrushes called the attention of the plastics world to the little town of Florence in western Massachusetts, where the Pro-phy-lac-tic Brush Co. has developed an injection molding plant equipped with 12- and 16-oz. machines to handle heavy section molding on a large scale.

At first glance, few molders realized that the brush backs were a product of injection molding because of the extremely heavy material sections, free from the bubbles and flow marks which show up so prominently in a transparent medium. With few exceptions, injection molding had previously been restricted to small, thinner-section pieces to insure against molding and cooling defects, and was thought of mostly in terms of speed and cutting production costs. Before they applied injection methods to these heavy sections, the company made a thorough study of the problems involved.

First, they fabricated complete brushes by hand from cast blocks to determine which, if any, of the available materials would produce the quality and appearance demanded, and decided that methyl methacrylate was best suited to the job. Next they figured that drilling and stapling the new material would call for changes from standard practice. Further adjustments were later made on these operations both because of the slight differences in physical and structural properties between cast sheets and molded pieces, and to meet the requirements of high-speed production.

After the selection of the material, the question of styling and color was taken up in the same experimental fashion. Then numerous shapes of handles were carved and bristled with natural and synthetic bristle. One style of brush was selected and work began on the first mold. Because the synthetic bristle helped to enhance the brilliance of the backs, it was decided that nylon* should be adopted.

Next came the molding proper, where many earlier theories of technique had to be discarded and new methods of mold construction and gating perfected. The timing of the cycles was found to be entirely different from anything previously experienced. This in turn had its own effect on heating conditions in the injection machines and the resultant plasticizing of the material. The company's engineers had one additional problem of their own: brush backs had not only to look well after molding, but also after they had gone through the complicated process of drilling and stapling to

* Prolon is the Pro-phy-lac-tic Brush Co.'s trade name for these du Pont nylon bristles.

***1**—Plush, pug dogs and plastic plaques like this adorned the Victorian drawing room. This finely detailed reproduction was molded in a hand-carved steel die of the 1860's.* **2**—*From the original molds come also modern replicas of old handmirrors of cellulose acetate in delicate pastel shades. Birds and flowers were genteel motifs for ladies.* **3**—*To-day's dressing-table appointments depend on color and line for their charm. This set of transparent acrylic comes in crystal, ruby, sapphire and emerald*

BELOW PLATES, COURTESY ROHM & HAAS CO.

4—*Plastic jewels made from acrylic molding powder inspired the colors for sparkling acrylic brushes bristled with nylon. Sturdy, lightweight, chip-proof, easy to keep clean, these brushes are utility items despite their fragile appearance*

apply the bristles. The whole thing required a careful formulation of molding powder and the closest cooperation of material suppliers and machinery manufacturers.

Colors of the brushes had to be light-fast for display in windows and in lighted show cases, where good heat-resistance is also called for. Finally, the molding powder had to be made and kept spotlessly clean. One tiny dirt speck may cause rejection of an expensive brush. This required constant supervision and expert housekeeping, even to the point of vacuum cleaning the machines.

Such pioneering work in heavy section molding should point the way to further developments in injection work, and more difficult items along these and other lines may be expected to make their appearance.

The Pro-phy-lac-tic Brush Co., for 80 years proprietary molders, made their first plastic hairbrushes shortly after the Civil War, using a thermoplastic formulation which included resin, shellac, fillers and color pigments. Two or three years ago, some of these old brushes, together with a few powder boxes, mirror backs, duelling pistol cases, cameos, daguerrotype cases and a handful of buttons, were discovered in an obscure storage vault in an excellent state of preservation—mute witnesses to the aging qualities of these earliest of plastic materials. Their finish was still good and they were but slightly warped.

A search was immediately instituted for the molds from which these delicate designs of another age were made, and in due time these also were brought to light. Among them—and representative of the type of work done in the 1860's—was the plaque showing George Washington crossing the Delaware here reproduced. This mold, about $7\frac{1}{2}$ by $9\frac{1}{8}$ in., is beautifully hand engraved, the (*Please turn to page 94*)

Background for blueprints

A PRACTICALLY all-plastic office makes its début this season with sheet stock, laminated materials and extruded plastic stripping cleverly and judiciously used to create an office along smooth, modern lines. It is designed by R. Doulton Stott, industrial designer, for his own use.

Dominant colors used in the decorative scheme are blue and gray. Warm tones of blue, gray and coral are used with light furniture. Sailcloth draperies, with the Stott monogram sprayed on, hang at the windows. Oyster-white translucent laminated sheet stock with a smooth, glossy, washable surface comprises the major part of the wall area. It is broken up into panels by vertical extruded strips of white cellulose acetate butyrate. These strips not only conceal cracks between the plastic wall panels but also hold the panels in place.

Plastics have been widely reccmmended by designers for specific architectural purposes, but Mr. Stott has made further advances in the development of new uses in the planning of his own office. Extruded plastics designed for architectural and furniture trim serve for different structural purposes. Other plastics are found in handles, walls and ceiling fixtures.

A blue carpet, flush with the outside walls but separated in the center by a curved line of coral linoleum, is partially outlined by a thin line of white plastics. The plastic is used as a dividing strip between the carpet and the linoleum. Fastened tightly to the floor, it was found to prevent the usual dust crack. Further, it protects the edge of the carpet and helps keep it in place.

A curved counter projecting into the inner office runs along the convex portion of the wall. Covering the surface below the counter is a blue fabric-type wall covering. And beneath, a laminated plastic baseboard about 4 in. high runs right to the floor—proof against scuffing and rough wear. The counter itself is a handy place to display working models. Novel use is made of extruded moldings to hold photographs much in the same way that etchings are hung for exhibit. Lengths of the plastic molding are inserted horizontally in the wall strips as racks to hold pictures.

Even with these departures from conventional construction, workmen using ordinary tools made the installation. The extruded shapes need no special handling and can be bent with ease around corners and made to conform to the design. Strips are cut, drilled, nailed and sawed. It is claimed that plastic strips can be installed faster than metal and can be worked right on the job. *(Please turn to page 106)*

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1—Warmth of color and soft light diffused through translucent laminated wall panels and egg crate fixture are shown in the office interior opposite. White extruded strips hold wall panels in place, separate blue carpet edge from coral linoleum and trim the sliding doors. Baseboard, too, is of laminated plastics. 2—Foyer shows egg crate ceiling fixture. 3—A corner of the main office cut off by the accordian-like door at the left. A hung ceiling made of cellulose tubing set into a framework of extruded plastic strips is unique. Lighting fixtures have plastic parts

COLOR PLATES (OPPOSITE PAGE) COURTESY TENNESSEE EASTMAN CORP.

1

2

1—A compact machine for instantaneous sound recording and reproducing, the Audograph uses specially treated cellulose acetate disks. 2—These lightweight plastic records, in three convenient sizes, can be kept in permanent reference files

Double talk on the record

Instantaneous, permanent recording and reproducing of two-way conversations, sound or code signals are made on inexpensive paper-thin, flexible plastic disks

MIGHTIER than the sword, the written or printed word has a permanence that makes either history—or trouble. With radio broadcasting, communication, code transmission and important conferences the order of the day, the spoken word now becomes a major weapon in national and industrial affairs. As a result, a new system for instantaneous, accurate, sound recording and reproducing steps out of the business world into the military field.

This technique makes use of the Audograph, a compact acoustic machine which records sound instantly on inexpensive transparent plastic disks—paper-thin and flexible. Sound picked up by microphone, by direct connection with radio set, leased telephone line, etc., or dictated directly to the machine, is electrically amplified to provide power for recording. Applied by a new method, this power is used to mold an actual image of the sound waves into the thermoplastic record at pressures in excess of 25 tons per square inch. Immediately after recording, the turn of a knob permits these records to be played back through earphones or a loud speaker. Records are easily inserted in the machine as they slide in from the side and bend to fit over the top of the machine (Fig. 1). A manual control sets the machine for recording, listening and neutral positions. Foot and manual controls are also available for dictation purposes.

Clean, chipless records are formed from very thin gage transparent cellulose acetate sheet—.005 and .0075 in. thick. These are cut to size and then given a special surface treatment which prevents warping, makes the disk impervious to moisture or ordinary temperature changes and preserves the finish. Both sides of the disk may be used as the embossing does not go through the plastic.

Records come in three sizes—12 in., $9^1/_4$ in. and $7^3/_8$ in. in diameter, providing, respectively, 61 min., 31 min. and 16 min. of recording time on *each* side. A 12-in. record, which sells for 10 cents, when used on both sides, carries 2 hrs. and 2 min. of recording at a cost of less than 5 cents per hour.

Records may be played back as many times as desired without appreciable loss of quality or introduction of undesirable surface noises. Light, flexible and unbreakable, the records may be mailed at letter postage rates or filed in an ordinary filing cabinet for future reference. The equivalent of a year's recordings at the rate of 24 hrs. a day may be filed in one cabinet drawer. An identifying cardboard center on each disk may be marked with a number, name or brief description and cross-indexed with a card file. This provides a permanent, audible file of conferences, radio broadcasts, telephone conversations, business dictations, research records or communications and messages as they were actually transmitted and received.

While many of the applications of the Audograph in military uses must necessarily remain secret, a few specific uses which may be employed by the Army and Navy include: Ground-to-plane recording for airways traffic control; radio interception of code messages; enemy (*Please turn to page 94*)

Flexible coatings for textiles

by MARIAN WYLE CERF*

THE diversion of crude rubber supplies to wartime needs, coupled with Japanese inroads on the rubber producing areas of the Far East, places special emphasis on the use of synthetic-coated water-repellant fabrics which replace oil- and rubber-finished materials.

For the past few years, flexible coatings of various kinds, as distinguished from the stiff, artificial-leather variety, have been developed for and applied to an assortment of lightweight, flat weave materials. Japanese habutai—"China silk"—has been until the present crisis the most commonly used base for these finishes. Oiled silk, a translucent sheet material made with chinawood or tung oil, was the first fabric of this type. This material, imported for years from England in the form of raincoats and tobacco pouches, was first duplicated for commercial use here by certain large electrical manufacturers who had previously used the necessary equipment to oil fabrics for insulation purposes.

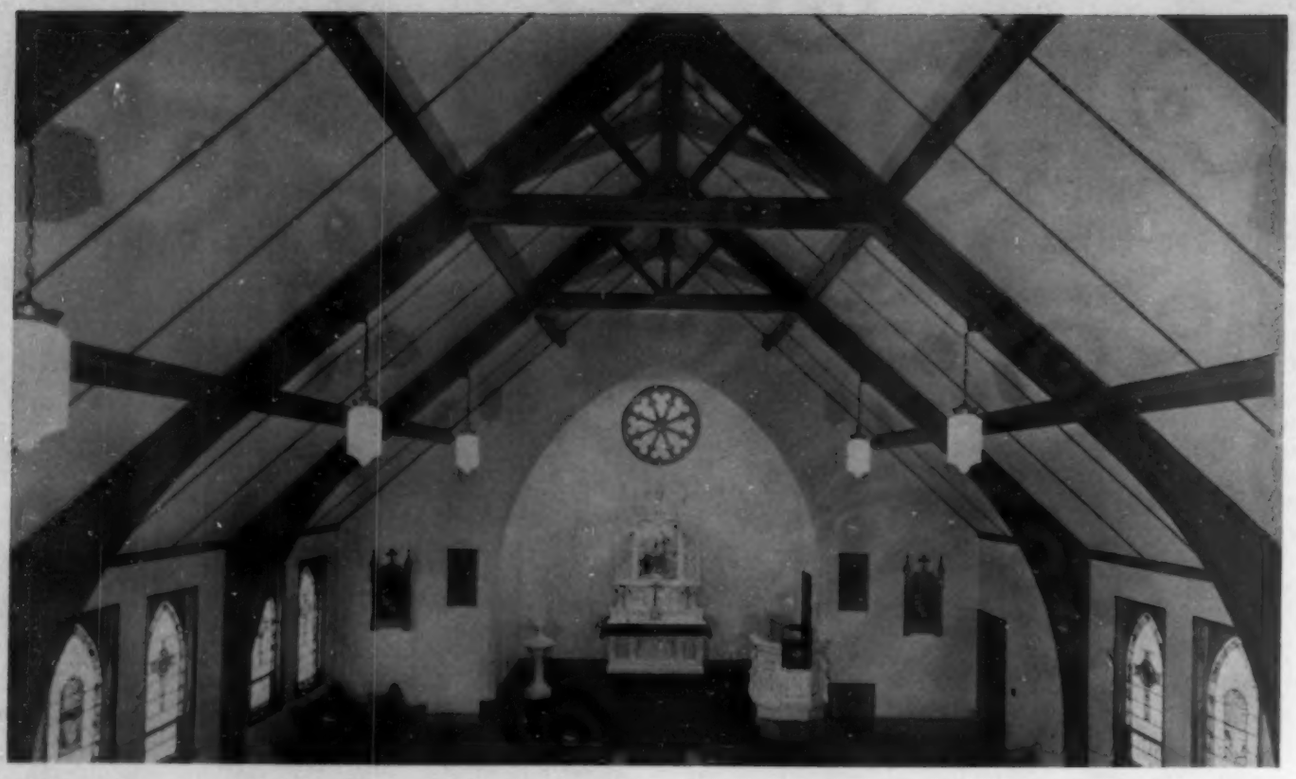
Starting in a small way some ten or twelve years back, oiled silk gained enormous popularity in the middle thirties and was sold from coast to coast for raincoats, umbrellas, shower curtains, food bags and other water-repellant items. The objectionable odor of the oils used, however, led to further experimentation and gradually "odorless" alkyd-type resin coatings began to replace straight oil finishes. The tremendous competition in the oiled-silk field stimulated the search for other processes; and in the late thirties the pyroxylin finish became an important substitute for the oil coatings, particularly for raincoat and shower-curtain use. This coating was made of plasticized cellulose nitrate pigmented in many cases to give an opaque effect which differed sufficiently from the oil finish to place the product in a different price bracket.

As world conditions made silk scarcer and higher in price, rayon and cotton came into the field. The old-fashioned oil process now began to disappear (oiling of cotton and rayon was not very successful) and pyroxylin became increasingly popular. Although its use on rayon fabrics already dates back several years, the soft pliable nitrocellulose finish on cottons is comparatively recent. It has only been on the market for about two years and has actually only begun to be used in quantity since the disappearance of the rubberized fabric. Unlike the straight stiff pyroxylin finish (used in artificial leather, which of course is not new), the plasticized cellulose nitrate is flexible and maintains the original drape of the material after finishing.

Vying for first place with this cellulose type finish are synthetic resin coatings—either urea-formaldehyde or vinyl—which have many merits but which are now limited because these plastics are required for military purposes. After the war, such coatings will probably (*Please turn to page 102*)

* Plasticote Co.

1—Replacing oiled silk and rubberized fabrics, textiles coated with a plasticized nitrocellulose finish start a new trend. Tablecloth and apron are durable as well as attractive. 2—Raincoat and air-raid warden suit of plastic-coated fabric are lightweight, afford good protection



1—The "boomerang" arch construction of this church at Leeds, Wis., makes use of glued-laminated wood to form a structural frame of great strength and beauty

Glued-laminated wood construction

AT the end of 1941 the United States was about halfway through the greatest industrial expansion program in its history—a tremendous two-year construction job of building factories, airports, armament plants, barracks and other large buildings and even some private homes—which involved an expenditure of about $10,500,000,000. This year another $8,500,000,000 will be spent on new construction with the defense proportion increased.

While plastics have had no major role in the building and construction field, considerable progress has been made in developing various architectural applications for molded, laminated and extruded materials. Some important inroads have been made in building hardware, and in kitchen, bathroom and electrical accessories, but these applications have for the most part represented color and finish. Extruded materials for wall moldings, trim, etc. (see page 41) are on important advance. More important are the synthetic resins used to bind and glue together inch-thick wood to form laminated rafters, arches, beams and roof trusses for structural work, which provide a speedy means of building airplane hangers, barns, farm buildings, auditoriums and other public buildings.

Modern research in glue has been responsible for many recent plastic-wood applications for houses, airplanes, torpedo boats, etc. Developments in casein, urea formaldehyde and phenolic resins for laminating purposes have resulted in waterproof, heat-resistant, quick setting, tenacious glues which are impervious to fungus or insect attack. Choosing the proper glue for any particular use is a problem so complex that the advice of a technician is recommended.

Wood has good resistance to tension and compression as well as to the bending to which arch ribs may be subjected. Efficient laminated wooden arch ribs and other members are now made available through the use of glues of proved durability which are used to bond laminates together as a unit so that resistance to sliding or shear is as great between the layers as within the wood itself.

Glued laminated construction has had a record of successful use in western Europe, particularly in Sweden, Germany and Switzerland, for about a third of a century. It is reported to be highly resistant to chemical deterioration and is consequently widely used where metal structures or metal connector built wooden structures would be subject to corrosion. First building of this type in this country, constructed in 1935 for the Forest Products Laboratory at Madison, Wisconsin, gave impetus to similar American construction.

In one manufacturing process of glued-laminated wood, developed in America by Rilco Laminated Products, Inc., selected finished grades of Douglas fir lumber 1 in. thick and in varying widths and lengths are firmly glued and bonded together with highly water-resistant casein glue under pressure of approximately 150 lbs. per sq. in. Straight pieces after gluing are pulled into a form which is set each time to give the

curve needed for the particular job required. This clamping procedure results in a pressure of more than 100 lbs. per sq. in. in the form, which yields full strength to this construction.

In manufacturing arches or rafters the boards or strips of wood are so assembled that the direction of the wood grain in individual strips is alternated in adjacent layers, in order to obtain the greatest possible strength. The curving of the wood grain in a laminated arch results in vastly increased load-carrying ability, in comparison to that of timber or planks hand sawed and spliced into a curved shape. As a result, such arches, trusses and beams are claimed to be non-sagging, wind-resistant, easily erected and assembled, simple in construction, architecturally correct.

These arches or rafters are treated with a water-resistant coating after manufacture which retards moisture absorption in general and protects the wood during shipment as well as in service. Especially developed coatings are used for protection against ordinary exposure, but where extraordinary moisture is anticipated, an additional coating of a special spar varnish is applied.

For centuries the arch has represented an important element in the structural and architectural design of buildings and bridges. Structurally it is a means of supporting loads over an opening between supports. As compared to a truss or a simple beam that may serve this same purpose, an arch carrying vertical loads exerts horizontal thrust as well as vertical pressure on its supports. An arch may consist either of a solid rib or ring, or of a framework similar to a truss.

Glued-laminated wood arches and beams have additional advantages of strength and economy. An arch rib incorporating a single large cross section involves no intricate framing and has better fire-resistance than an equivalent truss composed of smaller pieces. Since materials in the sizes used for laminating can be dried in a short time and rapidly set in place, danger of warping, twisting and shrinkage after installation is reduced to a minimum. Laminated members can be built up to larger cross sections and greater length on the job than would be possible if such members were constructed elsewhere and shipped over long distances. Also, laminated members can be built up from materials too small to be structurally useful otherwise.

Improved architectural beauty can be achieved in several efficient ways. Beams can be combined to overcome the undesirable appearance resulting from obvious sagging. Members may be gracefully tapered in depth, and incidentally save material which in a constant cross section would contribute little to strength and stiffness. Curved chords continuous through several panels may be used in place of panel length chord parts resulting in joint simplification.

Arches are very stiff and strong and in the larger sizes can be used for principal roof supports for clear spans up to 300 ft. Most applications in the United States incorporate more moderate spans in the range of 30 to 150 ft. This construction is ideal for such buildings as gymnasiums, airplane hangars, churches, bowling alleys, riding rings, storage warehouses, factories, club buildings, farm buildings, as well as others where there is an advantage in clear span construction free from interior posts or braces.

If, as many believe, we are approaching the era of prefabricated houses and buildings, this type of glued-laminated wood construction and design may be greatly utilized.

PHOTOS, COURTESY RILCO LAMINATED PRODUCTS, INC.

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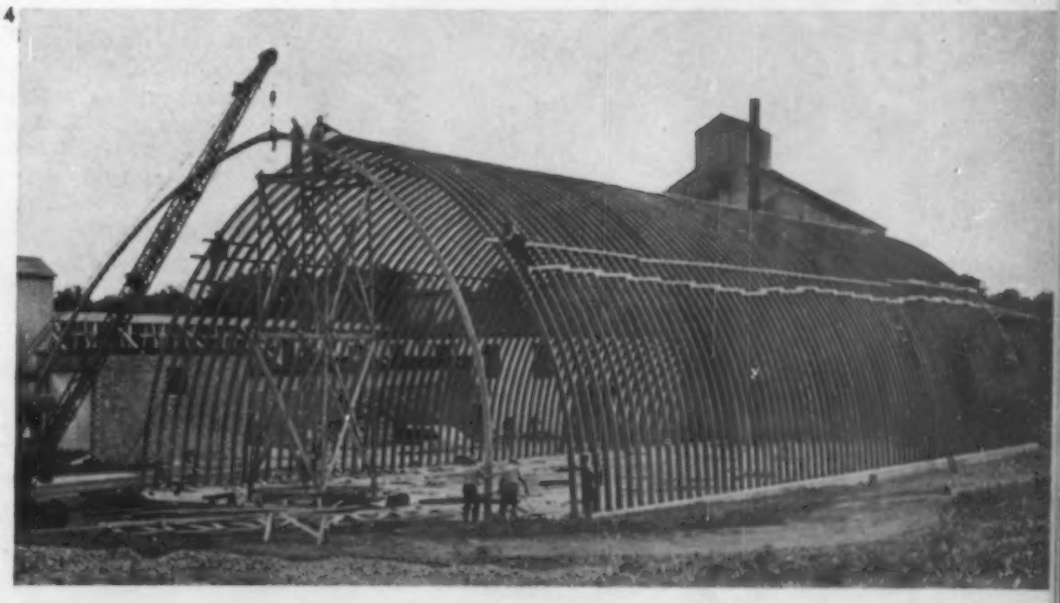
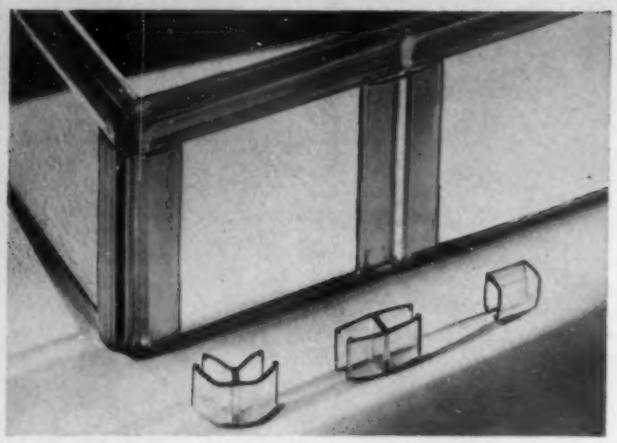


2, 3—*Beam arches and rafters of glued-laminated wood are adaptable for large buildings wherever unobstructed spans without interior posts or braces are desired. Weather-resistant bomber and airplane hangers above are economically and rapidly constructed from such factory fabricated material.* **4**—*One continuous unit from foundation sill to ridge, this strong grain storage barn of glued-laminated wood resists wind stresses and snow*

PRODUCT DEVELOPMENT

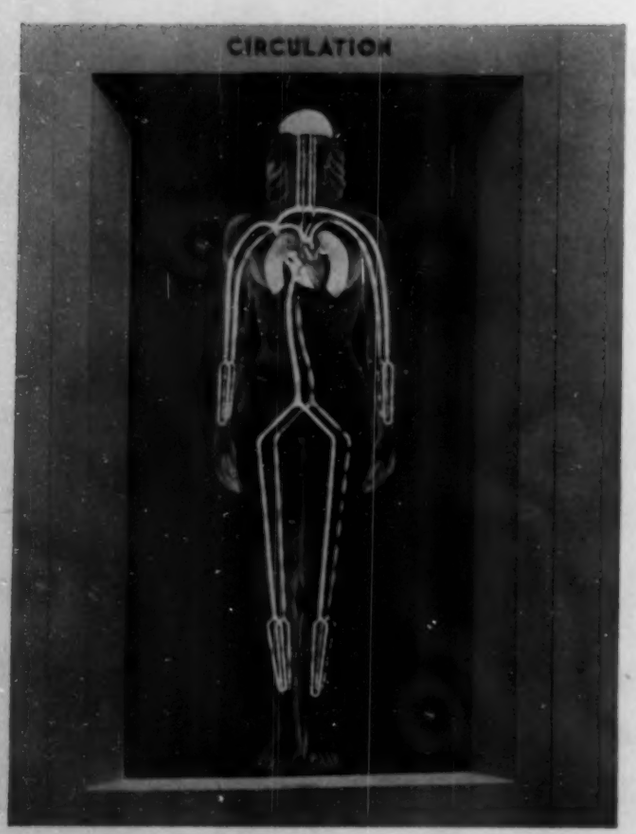
Clear counter clips



Effective merchandising of small items in 5 and 10 cent stores and department stores entails adequate counter display of the maximum number of different items within a small area. Most counters are separated into small sections by glass dividers which effectively separate classified groups of items and at the same time enable the shopper to see the assorted objects along the line. In the past, metal clips were used for joints and edgings. When shortages of stainless steel became apparent, it was necessary to find a substitute for the metal clips. The transparent extruded clips developed for the purpose proved so superior that they bid fair to become a permanent displacement. Besides improving visibility and appearance of the display, they help to prevent chipping. Clips are shaped to hold the glass in place without screws or other attachments, as shown above.

The clips are produced by cutting extruded strips of clear cellulose acetate butyrate into lengths corresponding to the various pieces of counter glass. Three types are being made: the "U," "H" and 90-deg. angle sections. Standardized dimensions were desired to accommodate glass of any thickness which might be used. Therefore, the base of the strip is made wide enough to hold the thickest of such glass dividers, and the wings can be pinched-in so that partitions of lesser thickness may also be held securely in a firm grip.

Credits—Material: Tenite II. Extruded by Extruded Plastics, Inc., for Pittsburgh Plastics Co., Incorporated



Luminous lady

An ingenious arrangement of methyl methacrylate tubing, light bulbs and synchronized mechanisms gives the illusion of blood circulating through this life-sized model, part of the science display at the Newark (N. J.) Museum. The gift of Louis Bamberger, Vice-President of the Board of Trustees, the unique exhibit was constructed by John Broomfield, electrical engineer, of Rye, N. Y. The figure itself is etched on a piece of plate glass, behind which are arranged 1500 pieces of cut and polished methyl methacrylate, each a different size and shape. The ability of this plastic to carry light around corners dictated its choice for the lady's circulatory system.

The apparent movement of the bloodstream is produced by bars of the plastic material, spirally striped with black tape in barber-pole fashion, which revolve before powerful tubular light bulbs. From the turning bars, hundreds of pieces of methyl methacrylate run to the plate glass, through which their ends can be seen. As the striped bars rotate, they cast alternate light and shadow on these pieces, and their glowing and fading ends give the effect of the pulsating movement of the blood. Veins and arteries are so colored that blood leaving the heart appears red, that returning to it, blue. To make the lady even more lifelike, the heart throbs at the normal adult rate with a faint ticking sound.

Credits—Material: Lucite. Figure: Harriton Carved Glass

Plastic-plywood "eight"

With the use of a steam iron, some strips of rubber from tire inner tubes, a few carpenter's tools and a lot of ingenuity, Coach E. A. Stevens (lower right) of Oregon State College, built the first 46-ft. fir plywood racing shells. Eight pieces cut from 4 by 12 ft., 1/8 in., three-ply panels were shaped into compound curves over each hull.

Three basic reasons determined the selection of the laminated plastic-plywood rather than the narrow cedar boards with which conventional boats are planked. First, the boat had to be able to withstand the abuse dealt out by 200 crew-minded youths who had very few boats to row. Second factor was cost. Stevens and student assistants built the entire shell, including outriggers, seats and other fittings at a total cost of about $50—purchase price of a new manufactured shell would be about $500. Third element was equipment. Only simple hand tools were required and a shell was planked out in 4 days—or about a third of the usual time required.

Construction was simple. Plywood pieces, cut to fit, were clamped in place, soaked with water and "ironed" with a home steam iron, while pressure was exerted by pulling on large rubber bands. After each sheet was formed, it was glued to the ribs, nailed for extra strength. Simple butt-joints were used with waterproof glue between the panels, and three coats of varnish applied for the finish. Only seams in the hull are the three around it and one down the center.

Credits—Durez-Resnprest plywood, M & M Wood Working Co.

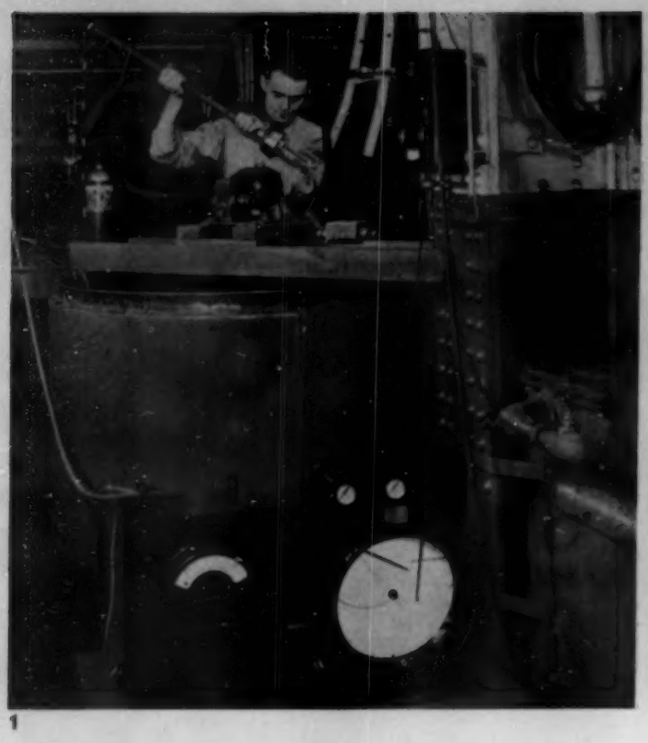
Adhesive for metals

For the lack of gutta-percha, a new plastic adhesive was born! When a scarcity in the former type of adhesive, used for bonding artificial leather to metal spectacle cases, made it imperative that a substitute be found, the eyeglass-case manufacturer collaborated with the plastic and raw material suppliers and their cooperative research produced a vinyl resin adhesive which surpassed the old. Based on polyvinyl acetate resins, the new adhesive, in contrast to the gutta-percha type, is dependable in behavior and uniform in composition, and forms a smooth, stable bond between leather or fabric and metallic surfaces. When applied, the vinyl resin adhesives become an integral part of the material; after being dried they are non-adhesive at ordinary temperatures.

These adhesives, it is reported, will adhere to any rigid surface free of grease or oil. They are suggested for use with metals, glass, fiber and transparent cellulose. Among other advantages claimed are these: They retain adhesive qualities indefinitely in storage; are soft enough so that they do not impair the flexibility and working qualities of the coated fabrics to which they are applied or react with metals.

Credits—Material: Vinylite. Developed by Zapon-Keratol Div., Atlas Powder Co.; Case-making Div., American Optical Co.; Plastics Div., Carbide and Carbon Chemicals Corporation

PRODUCT DEVELOPMENT



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Soybean protein fibers

by R. A. BOYER*

SYNTHETIC fiber production has been one of the most active and fertile fields for chemical research during the past twenty years. The tremendous growth of the rayon industry has stimulated the interest in work along this line not only of textile chemists but also of those employed in entirely unrelated fields. Until recent years the greater part of the work was devoted to production and improvement of the cellulose fibers such as the viscose, cupra-ammonium and acetate fibers. In 1936, however, Ferretti in Italy published his work on a new type of fiber, a protein fiber produced from milk casein. This fiber, called "Lanital" commercially, achieved a reputation as a wool substitute because of its chemical and physical similarity to wool. Although Lanital was eventually found to be inferior to wool in some respects, its production has increased steadily.

The success of Lanital inspired fiber research on a great many other proteins, among them fish protein, regenerated silk, peanut, corn zein and soybean. This paper deals with experimental work on soybean protein fiber. The research chemists of the Ford Motor Co., having a background of several years of soybean research, undertook in 1937 the development of a fiber from soybean protein. The soybean in many ways is an outstanding source of protein for fiber work. Economically, the project is sound: The supply of soybeans is very large and is increasing yearly; the large use of soybean meal at present is as a cattle food and this tends to keep the price stable and low; the bean is easily grown and finds favor with the farmers; soybean oil, which is fast becoming one of our most important vegetable oils, is recovered in the first step of the fiber production.

* Ford Motor Co.

Briefly the production of a fiber from soybeans is done in five main steps:

1. Extraction of the oil.
2. Extraction of the protein from the oil-free meal.
3. Dissolving of the protein to produce a viscous stringy solution.
4. Spinning the solution and hardening of the extruded filaments.
5. After-treatment and drying of the fibers.

1. The extraction of the oil is done by the continuous solvent extraction method. The crushed beans are washed counter-currently with hexane, which removes the oil. The resulting oil-free meal is then passed through steam-jacketed pipe for removal of the solvent. Although the Ford extraction equipment is of different design, the whole operation is standard in the soybean industry. Exception: meal prepared for fiber work is treated at much lower temperatures than meal prepared for cattle food.

2. Extraction of the protein (Fig. 1). We have found this to be a very critical and important part of the fiber preparation. Although the protein extraction is a relatively simple operation, extreme care must be exercised in order to produce uniform batches. There are many ways of extracting protein, some of which are closely guarded secrets. The indications are that the simpler methods will be the most satisfactory. One method is to treat carefully sized oil-free meal with a weakly alkaline solvent such as $^1/_{10}$ percent sodium sulfite for half an hour. The resulting solution is clarified either by filtering or centrifuging. The protein in the

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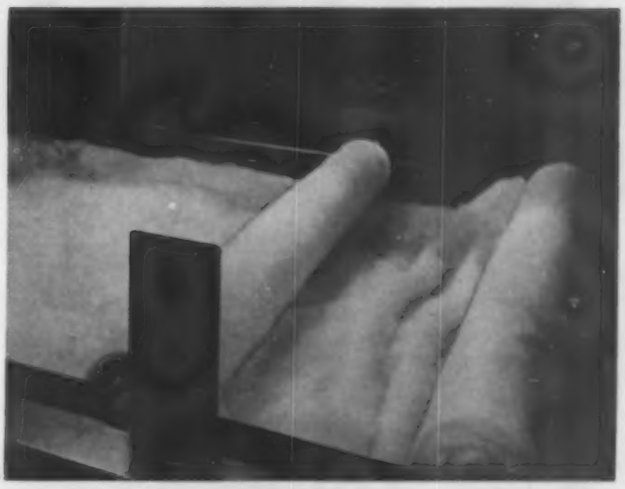
1—A critical part of the production of fiber from soybeans is the extraction of the protein from the oil-freed soybean meal. **2**—*The resulting solution is clarified by filtering or centrifuging in the stainless steel machinery shown.* **3**—*To produce a fiber, the solution first must be prepared for spinning. Here viscosity of the spinning solution is being checked before it is fed into spinnerets.* **4**—*After treatment in formaldehyde, fluffy fibers are fed into a picking unit, prior to cutting, drying, etc.* **5**—*Blending soybean fiber on rollers.* **6**—*Conventional cotton and worsted equipment is used to spin soybean fiber into yarn*



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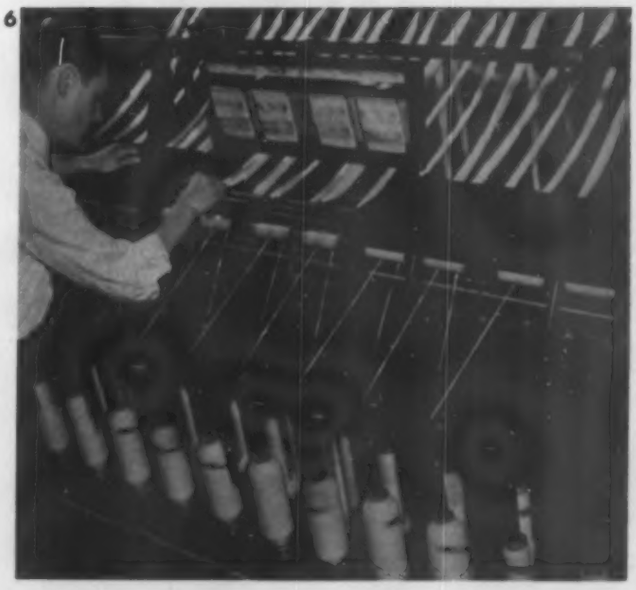

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solution is precipitated with an acid and the resulting curd washed and dried.

Because of the discoloration of protein by iron, each one of these steps must be done in stainless steel or glass-lined equipment. The pH must be checked and controlled constantly. We have found, for instance, that no two batches of soybean meal will have the same pH when treated with the same amount of sodium hydroxide under similar conditions. Accordingly the alkali is adjusted to bring each batch to the same pH. Clarifying an alkaline solution of protein satisfactorily is a very difficult chemical engineering problem. At present stainless steel centrifuges (Fig. 2) with automatic unloading devices are being used. However, much more work remains to be done on this point. Precipitation must be done at exactly the right temperature and pH in order to get a curd that can be handled satisfactorily during the subsequent washing and drying.

In spite of all these precautions we have found variations in the proteins. We have traced these back to differences in the variety of the bean from which the protein was extracted. There are indications also that the composition of the soil on which the beans were grown has a marked effect on the protein. In order to control this and have a uniform supply of beans for the fiber experiments, (*Please turn to page 106*)

Hemisphere solidarity

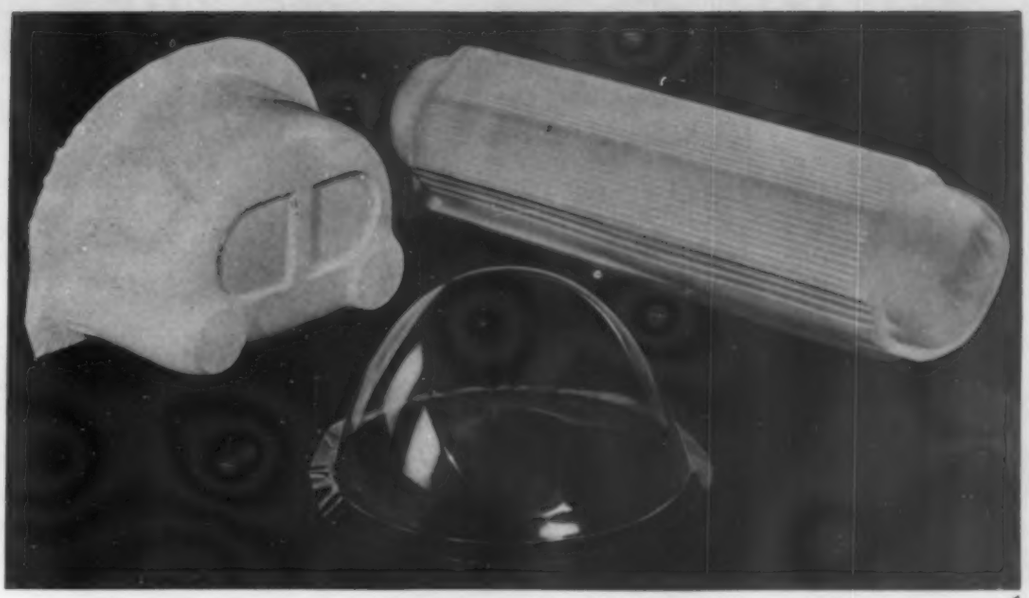
Examples of South American molding show clean detail and fine quality of workmanship

PHOTOS, COURTESY BAKELITE CORP.

TWO of our sister republics to the south are represented by the molded chessmen and electrical accessories shown on this page. From Santiago, where 90 percent of Chile's plastics is manufactured, come the chessmen of black phenolic and ivory urea. SHYF Sociedad Industrial, oldest of Chilean molders, uses 2- and 4-cavity molds for this detailed type of work, and has at present 28 Gotz hand presses varying in size from 25 to 300 tons. Electric heaters are used throughout the plant. The company manufacturers its own tools, and has lately developed a new type of accumulator which it hopes may find a U. S. market.

Christensen Masjuan of Buenos Aires, center of plastics manufacture in the Argentine, contributes the electrical plugs and outlets. Also of phenolic and urea molding material, these are cast in 3- and 6-cavity molds, with the threads of the plugs molded-in and metal inserts imbedded at the time of molding. These moldings appear to be the equal in quality and workmanship of similar parts produced in the United States. This firm also makes its own equipment, including its hydraulic presses, which are semi-automatic and use flash type molds.

Credits—Material: Bakelite and Bakelite Urea.



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1—*Compound curves and unusual contours are possible by sheet molding or deep drawing methods, as shown in an unfinished radio covering, ribbed fluorescent light shield and an experimental, mite-sized airplane turret.* **2**—*Giant perfume display bottles are formed from thin cellulose acetate halves*

Sheet molding of thermoplastics

DURING the past few years, commercial methods of deep drawing, swedging or sheet molding of thermoplastics have been greatly expanded. The development was spurred by the availability of a wide range of materials—cellulose acetate, ethyl cellulose, acrylic, vinyl, etc.—in a variety of gages and sizes, the ease of fabrication, the advantages of strength in large pieces and the labor savings possible. Such processes consist basically of transforming a more or less two-dimensional sheet into a three-dimensional form by means of dies under heat and pressure. The term *drawing*, as distinct from embossing, usually means the process in which sufficient material flow takes place to make the wall thickness of the finished piece about the same as that of the original stock. *Embossing* denotes that a certain amount of stretching takes place, with consequent reduction in wall thickness. Some manufacturers combine both processes—drawing for strength, and embossing for unusual effects.

For seamless articles with compound curves, angles or ridges, thermoplastic sheet molding can be used to advantage. One process molds in a single operation such intricate shapes as are pictured here. This method is said to provide an extremely low die cost and therefore to make small as well as large production runs possible. Prior to molding, the flat plastic sheets are pretreated, racked and allowed to dry. Molding takes place between conventional male and female dies, and forming is completed under heat and pressure.

Thin-walled articles—.005 in. to .500 in. thick—are highly practical. The giant bottle (Fig. 2) 27 in. high and 13 in. in diameter, is produced from .020-in. cellulose acetate sheet.

Finished drawn products may be clear, opaque or translucent like the ribbed fluorescent light fixture (Fig. 1 right).

Decoration by printing, embossing, silk screening or lithographing may be applied to the finished product or performed on the flat sheet before molding and registered with the die.

The diversified contours and angles made possible by sheet molding or deep drawing methods permit interesting designs in the realm of lighting fixtures, airplane turrets, transparent machine guards, instrument housings, containers and in packaging and displays. Methods of drawing transparent containers and displays are discussed elsewhere in this issue[1] and in the literature.[2] The great depths of draw obtainable, the light weight, ease of cleaning and moisture-resistance of the materials generally used, combined with the economies of molding, open a field of wide use.

Credits—Sheet molded items by Walco Plastics Company.

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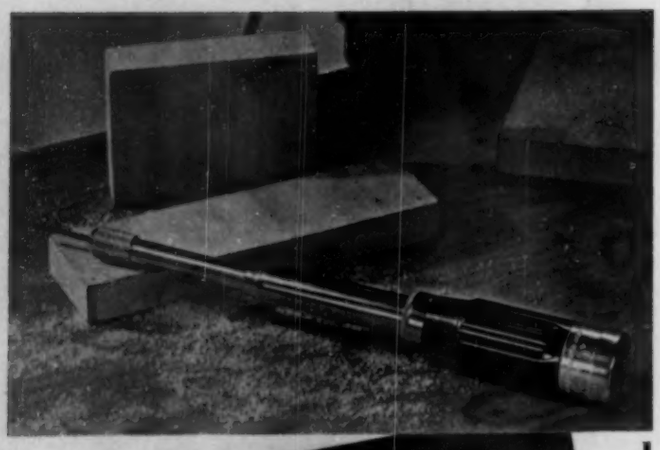
[1] See page 66.
[2] *Modern Packaging*, Sept. 1940, page 88., Ibid., Jan. 1942, pages 83, 88.

PLASTICS in REVIEW



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1 "Mr. Punch" is the name given by the Millers Falls Co. to its automatic drill No. 188A, created for the man who likes to putter around the house, boring holes and putting up fixtures. "Mr. Punch's" shiny black handle is of Bakelite phenolic, molded by Watertown Mfg. Co.; and the drill's increased appeal is credited to the new handle's trim appearance, smooth serviceability

2 For economy-minded businessmen or chatty homebodies: a telephone monitor encased in black Durez molded by T. F. Butterfield, Inc. The Tele-Trol's dial is of white enamel with raised chromium numerals. Put out by Holcomb and Swenarton, who have equipped it with a simple touch lever and an automatic chime which warns the user when his three minutes are about up. The device is also used for checking operations in time study work

3 Clear and tinted threads of extruded Tenite are interwoven with shimmering metallic filaments to fashion a glamorous slipper for dining and dancing. Evening's end finds the lady's foot cool and comfortable, says the manufacturer, Vale Shoe Co.; and the material, extruded by the Rex Co., woven by Trimmings, Inc., is lightweight, long-wearing and won't tarnish

4 Devotees of bowling are enthusiastic about Trophy Radio Co.'s unit designed in the shape of a bowling ball. Durez was chosen as the medium for the radio housing when, after experiments with other materials, it was discovered that only a plastic could give the illusion of a bona fide bowling ball and at the same time be functionally satisfactory. Raymond Laboratories, Incorporated, is the molder of the radio

5 A combination torchlight-flashlight incorporating a 5¾-in. rod of Lucite is offered to traffic police and country drivers by Traf-O-Lite, with emphasis on its use as a warning signal. The red-lacquered side of the plastic rod will glow brightly through rain and fog, while the crystal-clear end emits a strong, direct beam like that of a flashlight. Reported to be virtually unbreakable, the plastic lens weighs little and has high light transmission. The driver shown here has attached his light to the fender with a suction cap

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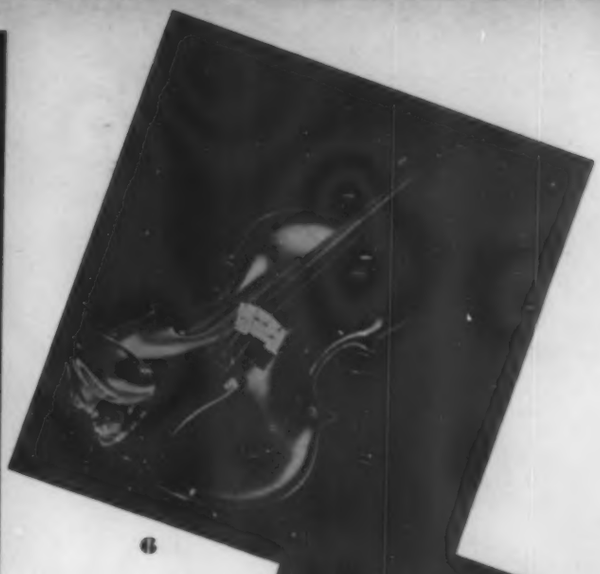

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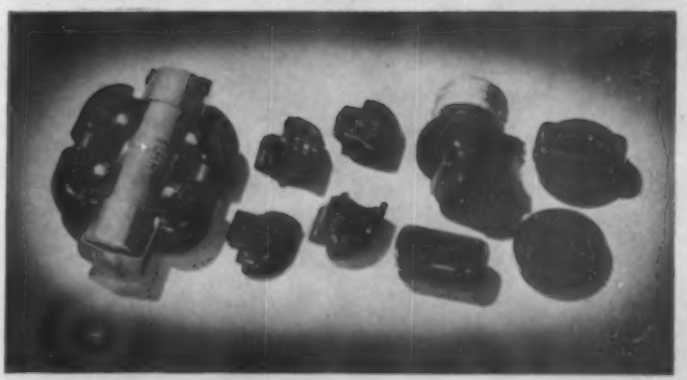
6 New violin chinrests are injection molded of amber and black Lucite by Patent Specialties Mfg. Co. More sanitary than their wood or rubber predecessors, they are odorless, heat- and perspiration-resistant, will not chip or buckle under the artist's most temperamental gyrations. The molded acrylic is said to have a special quality when warm of clinging to the chin—a comfort to nervous virtuosos!

7 No city slickers are this distributor cap and rotor, spark coil cover and insulated timing gear pinion. Molded of sturdy Bakelite with positioned metal inserts by Reynolds Molded Plastics, they are ignition parts of tractors used on up-to-date farms. Other uses of plastics in farm machinery include tough, oil-resistant laminates for distributor breaker arms and synthetic resin-base paints to insure weather resistance

8

8 Carved and twisted Plexiglas forms frame and easel of a clock whose face, like that of the Cheshire cat, seems to be floating in space. The lightweight plastic parts, practically unbreakable, were developed by Semca Co., in a clear crystal or in soft colors to harmonize with the clock's surroundings



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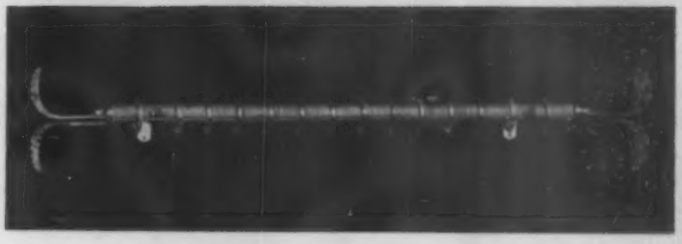
9 Tough molded phenolic goes into renewable fuses which dispense with old-style brass parts. When a fuse blows, a red light shows through the top. By a clockwise twist of the plastic top the circuit is completed. A light holder is permanently attached to the ferrule type of fuse, fastens to the other by a spring clip. Signalite Fuse Co. manufactures and molds the fuses of Durez



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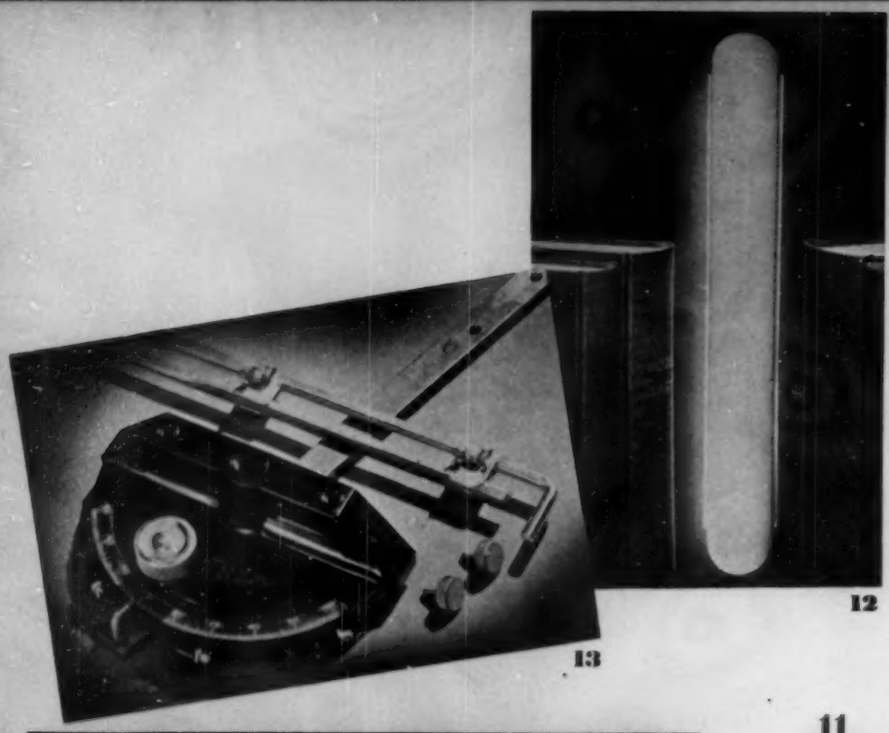
10 Smart new curtain rods are formed from extruded D-shaped Lumarith rod in crystal and colors, wound helically about a wooden core. Extruded for Schwab & Frank Co. by Detroit Macoid Corp. Rings and finials are also of this cellulose acetate. Injection molded by Modern Plastics and Plano Molding Company



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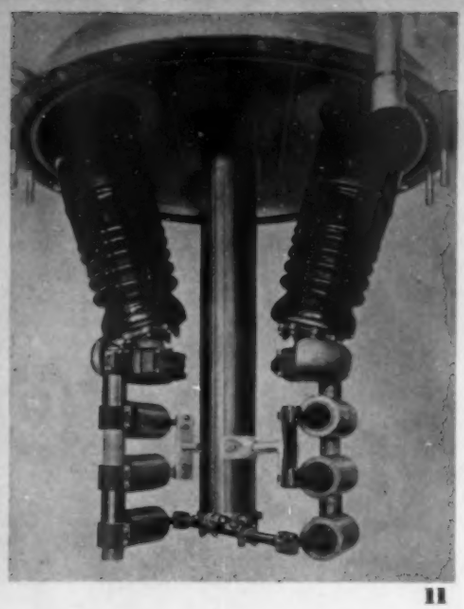

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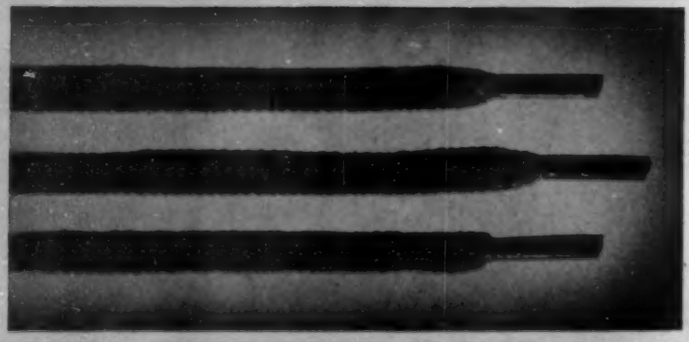
11 Outdoor switchgear must have dependable insulation which will also withstand mechanical stress and weathering. Pacific Mfg. Co. uses molded and rolled laminated tubes of Bakelite phenolic for expulsion contact, rotating unit and contact supporting bracket. The heavy-duty plastic insulation of the expulsion chamber is reported to stand up well under impact, heat and heavy torque of making and breaking circuits. Remler Co., molder

14

12 Decorative removable shields by Spero Electric Co. cover bare fluorescent lamp installations, both channel and bracket. Extruded of Tenite by Carter Products Corp., the RSP plastic diffusing shields come in white and in colors, and serve to diffuse light, to eliminate glare and to dress up restaurants, theatres and night clubs or may be used at home



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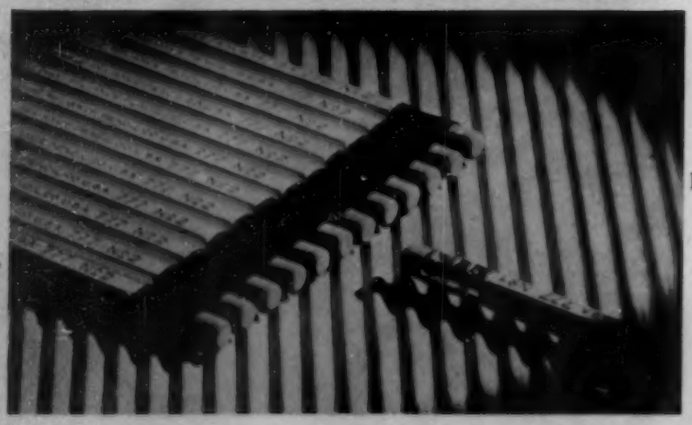
13 That plastics can be adapted to the heavy-duty tool field is seen in Delta Mfg. Co.'s use of Durez for their auto set miter gage head. Threads are molded-in; the angle range is debossed in the head and made legible by white enamel wipe-in. Threads are also molded-in, requiring no special cutting operations, and they won't strip easily. No japanning, painting or lacquering is required other than wiping in the enamel. The lighter weight of the plastic makes the tool easier to handle, yet it will stand hard wear. Eclipse Moulded Products Co. is the molder



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14 Said to be the first completely plastic-lined acid pump, Model AC put out by A. R. Wilfley & Sons, Inc., employs Haveg, phenolic asbestos material, for its impeller also. No metal comes in contact with the solution, and wetted pump parts can be either of a hydrofluoric-resistant grade of the material or of a type resistant to hydrochloric acid solutions of any concentration and temperatures up to 250 degrees. The model shown, running at 1450 r.p.m., with dynamic head of about 40 ft., will pump 110 gallons per minute. The illustration shows the pump disassembled exposing the Haveg lining and impeller. There are no rubbing contacts between the impeller and the lining of the pump casing

PLASTICS IN REVIEW

15 Because in this application one pound of plastics may release more than three pounds of metal, even the lowly shoelace tip may make its contribution to the war effort. In place of metal, cellulose nitrate sheet is supplied to shoelace manufacturers, who cut it into strips and crimp tip onto lace. It is estimated that more than half a billion laces of all types, from infants' shoes to cavalry leggings, were plastic tipped last year. Claimed to outlast metal tips, these Pyralin tips can't cut or scratch impatient lace-yankers

16 Tiny, but nevertheless a metal replacement, the plastic pencil ferrule is manufactured for Reliance Pencil Corp. by Universal Plastics Corp. from Tenite, Fibestos and Bakelite cellulose acetate. Smooth, ridgeless, the ferrules are colorfast and tasteless—a boon to the habitual pencil gnawer

17 Large molded section for use in the automotive field is the radio grille dash section made of Resinox by the Bay Mfg. Div., Electric Auto-Lite Co. Since color is molded-in, the plastic, naturally tough and durable, will not show surface wear

18 Switch handles on Easy Washing Machine Co.'s late models are molded by Gits Molding Corp. of Lumarith based on Hercules cellulose acetate flake. In addition to improving the appearance of the machine, plastics handles will not chip nor discolor

19 Handles, rails and legs of decorative cocktail and coffee tables are made of sparkling, stainproof Plexiglas. Designed by Industrial Arts, Inc., they look like glass, yet are so light that they can be moved about the room with no effort at all, and the clumsiest guest is unlikely to break one

20 Molded of Lumarith, the brace in this rear-view mirror is pale gray to harmonize with the interior trim of most 1942 cars. It can be cleaned with a damp cloth, won't chip nor rust, and will retain its luster indefinitely. Molded by Universal Plastics Corp. for Yankee Metal Products Corporation

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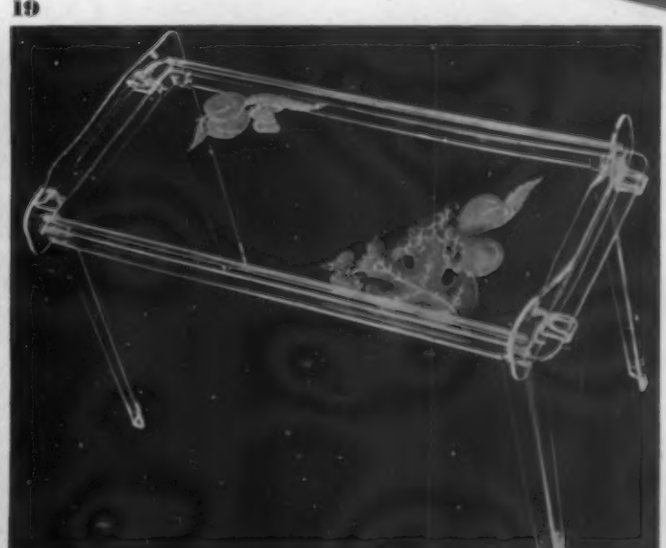


An engineer looks at plastics*

by J. R. TOWNSEND**

IT is necessary to have a broad picture of this subject if our conclusions are to be supported by the known facts. The confines of this discussion will not permit time to treat in detail all of the items that are involved. It is hoped that these remarks will stimulate thought and discussion and may serve to point the way to a strong constructive program for the Society of the Plastics Industry. Much can be accomplished by the cooperation of the manufacturer of the plastic, the builder of the machinery, the producer of the plastic part and the consumer. The industry is an extraordinarily virile one and much of the chaos is due to its youth and energy. We also have the stimulative force of defense economy to aid progress.

It is not the purpose of this discussion to cover novelty items or ordinary consumer goods that are sold at a price and are not intended to give long service. I wish to present to you the engineering considerations that are important in the use of plastics where continued, safe service is desired. These considerations apply not only to reliable data that can be used in design but also to all of those factors which relate to permanence under the conditions of service. As we shall see later, these are manifold. There are, strictly speaking, two broad engineering uses of plastics: First, as an electrical insulating material, and second, as a material of construction. The first use is important, since the need for replacement materials for electrical insulators in the last war, due to the increase in the price of rubber, did much to stimulate the development of phenolic plastic. Shellac, a natural plastic, was limited in strength as a structural material and also in its resistance to heat. Bitumen had similar shortcomings. Phenolic plastic, on the other hand, had tolerable electrical properties and in addition had strength and resistance to heat and to solvents, all of which are important in electrical use. Cellulose nitrate was available, but had serious fire hazard. Casein was limited to cast parts.

The period since 1918 has produced over 105 trade-named products and possibly 60 types of compound. Each type of compound has many grades and hardnesses. For example, one manufacturer of cellulose acetate has 6 grades, 17 compression hardnesses or flows and 13 injection hardnesses. The field of available materials is thus bewildering; and if we add color and transparency to grades and hardnesses, we have almost unlimited selection.

Now, what has been done to systematize the vast array of materials and what place do they have with competing natural materials and metals as materials of construction? In the discussion that follows, I have used the chemical or generic term for these plastic compounds in order to simplify the discussion and to be as fair as possible in our discussion of particular products.

The considerations that an engineer must take into account are:

1. The crucial use of the material as contrasted with an exploited use. For example, phenolic plastic is resistant to heat and solvents and its physical properties are sufficient for ordinary use. This combination of good electrical and mechanical properties, such as resistance to cold flow, permits phenol plastic to be used not only as an electrical insulating

* Presented at the General New England States Meeting of the Society of the Plastics Industry, Hartford, Conn., Dec. 2, 1941.

** Bell Telephone Laboratories, Inc.

TABLE I.—COMPARISON OF PLASTICS WITH OTHER CONSTRUCTION MATERIALS

Specific Gravity		*Tensile Strength, lbs./sq. in.*		*Modulus of Elasticity, lbs./sq. in.*	
Lead	11.34	Alloy steel	189,000	Alloy steel	30×10^6
Copper	8.89	K Monel	185,000	Structural steel	30×10^6
Phosphor bronze	8.81	Phosphor bronze	120,000	K Monel	26×10^6
K Monel	8.80	Nickel silver	108,500	Nickel silver	20×10^6
Nickel silver	8.68	Structural steel	85,000	Copper	16×10^6
Structural steel	7.85	Duralumin	55,000	Phosphor bronze	15×10^6
Alloy steel	7.80	Polyamide	50,000	Zinc die cast	13×10^6
Zinc	7.14	Copper	47,000	Zinc	12×10^6
Zinc die cast	6.60	Zinc die cast	35,000	Duralumin	10×10^6
Aluminum die cast	2.90	Aluminum die cast	29,000	Aluminum	10×10^6
Duralumin	2.79	Aluminum	22,000	Aluminum die cast	10×10^6
Aluminum	2.70	Zinc	17,500	Glass	9×10^6
Glass	2.60	Wood	16,000	Lead	2.5×10^6
Concrete	2.31	Plywood	9,600	Concrete	2×10^6
Lignin fiber	1.45	Glass	9,500	Plywood	20×10^5
Phenolic plastic	1.38	Lignin fiber	9,500	Wood	18×10^5
Cellulose acetate	1.32	Phenolic plastic	7,500	Lignin fiber	17.5×10^5
Hard rubber	1.30	Hard rubber	7,000	Phenolic plastic	12.5×10^5
Cellulose acetate butyrate	1.28	Polystyrene	7,000	Methyl methacrylate	5×10^5
Methyl methacrylate	1.18	Cellulose acetate	6,700	Polystyrene	4.5×10^5
Polyamide	1.14	Cellulose acetate butyrate	5,000	Polyamide	4.5×10^5
Polystyrene	1.06	Methyl methacrylate	5,000	Hard rubber	3×10^5
Plywood	.68	Lead	2,700	Cellulose acetate butyrate	2.7×10^5
Wood	.63	Concrete	200	Cellulose acetate	2.7×10^5

TABLE II.—RATIO OF TENSILE STRENGTH TO SPECIFIC GRAVITY

Polyamide	43,860	Lignin fiber	6,550
Wood	25,400	Phenolic plastic	5,430
Alloy steel	24,230	Hard rubber	5,380
K Monel	21,020	Zinc die cast	5,300
Duralumin	19,710	Copper	5,290
Plywood	14,120	Cellulose acetate	5,080
Phosphor bronze	13,620	Methyl methacrylate	4,240
Nickel silver	12,500	Cellulose acetate butyrate	3,910
Structural steel	10,830		
Aluminum die cast	10,000	Glass	5,850
Aluminum	8,150	Zinc	2,450
Polystyrene	6,600	Lead	240
		Concrete	90

material but also as a structural material. This is very helpful in many designs. The use of cellulose acetate as interleaving material for coils employing fine wires, such as No. 36 gage, is another crucial use of plastic material. Cellulose acetate interleaving provides excellent insulation resistance and strength and has a high degree of chemical stability which prevents the fine wires from corroding. A further crucial use of plastics is that of methyl methacrylate and cellulose acetate for windows where clarity of view is important. In each of these cases no other material can be expected to perform as well; and this is the criterion of the crucial use of material as contrasted with an exploited use Exploited uses of the material usually relate to novelty and appearance which are employed to intrigue the purchaser.

2. Plastic as a material of construction as compared with other available materials, both natural and synthetic, as shown by Table I. This table covers specific gravity, tensile strength and modulus of elasticity. Table II, which is based on Table I, shows the ratio of tensile strength to specific gravity. This table is a challenge to the designer. Here it can be seen that wood is superior to alloy steel from the standpoint of ratio of tensile strength to specific gravity, and that the plastic materials are superior to zinc die castings, glass, zinc, lead and concrete. Among the dynamic properties of structural materials, one of the most important is Izod impact strength. Table III shows how the various plastic materials compare from this point of view.

3. Its place as an electrical material. Tables IV and V give the electrical properties of commonly used plastic materials.

4. Special use requirements. Table VI lists other considerations which are of primary importance in the use of plastics. Of these various considerations one of the most important relates to stresses developed in a material during the molding operation. In the case of compression molded cellulose acetate, if the press conditions are not right, unmolding will occur during the life of the molded part. This is exhibited by the formation of "sharkskin" and the appearance, over the surface of the material, of irregular cracks and surface roughness seeming to outline the original grains of the material which apparently were improperly coalesced. In the case of injection molding, particularly where the material separates in the mold going around inserts to form two or more streams of material, there is improper fusion of these separate streams of material resulting in welds. These welds may have as little as $^1/_{20}$th of the impact strength of the parent material. Little is known about this property at present, consequently methods of reducing weakness of welds is an unsolved technical problem. Whereas it is sometimes possible to so design parts as to minimize welds, this cannot always be done. A proposed method of study is to make an im- (*Please turn to page 108*)

TABLE III.—NOTCHED IZOD IMPACT, $^1/_2$-IN. × $^1/_2$-IN. BAR

Material	*Foot-Pounds*	*Cost per Pound*
Cellulose acetate	.20–> 4.00	.40
Cellulose acetate butyrate	.15–> 4.00	.40
Vinyl chloracetate	.15– 4.00	.55
Polyamide	.50– 2.00	5.00
Hard rubber	.20– .50	.40
Vinylidene chloride	.20– .40	.80
Lignin plastic	.20– .40	.18
Methyl methacrylate	.15– .40	.75
Phenolic plastic	.15– .40	.15
Urea-formaldehyde	.10– .40	.40
Polystyrene	.15– .30	.55
Aniline formaldehyde	.15– .30	2.00
Shellac	.05– .10	.25

TABLE IV.—ELECTRICAL PROPERTIES OF PLASTIC MATERIALS

Material	*Specific Gravity*	*Material*	*Insulation Resistance ohm-cm.*
Shellac	1.90	Polystyrene	10^{15}
Vinylidene chloride	1.65	Aniline-formaldehyde	10^{14}
Urea-formaldehyde	1.47	Methyl methacrylate	10^{14}
Vinyl chloracetate	1.40	Hard rubber	10^{14}
Phenolic plastic	1.38	Cellulose acetate	10^{14}
Phenol fiber	1.36	Cellulose acetate butyrate	10^{14}
Cellulose acetate	1.32	Vinyl chloracetate	10^{14}
Hard rubber	1.30	Shellac	10^{13}
Cellulose acetate butyrate	1.28	Urea-formaldehyde	10^{13}
Aniline-formaldehyde	1.23	Phenol plastic	10^{13}
Methyl methacrylate	1.18	Polyamide	10^{13}
Polyamide	1.14	Vinylidene chloride	10^{13}
Polystyrene	1.06	Phenol fiber	10^{13}

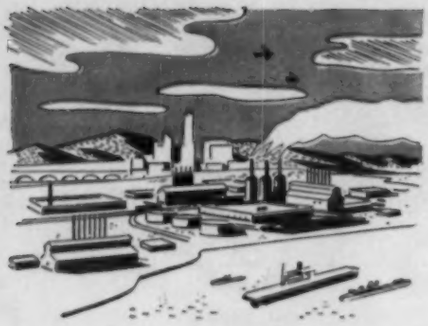
TABLE V.—ELECTRICAL PROPERTIES OF PLASTIC MATERIALS

Material	*Loss Factor ($K \times P.F.\%$) 10^6 Cycles*	*Material*	*Dielectric Constant 10^6 Cycles*
Urea-formaldehyde	18	Urea-formaldehyde	6.6
Phenol plastic	16	Phenolic fiber	5.0
Vinylidene chloride	12	Phenolic plastic	4.5
Cellulose acetate	11	Shellac	4.4
Cellulose acetate butyrate	11	Vinylidene chloride	4.0
Polyamide	10	Cellulose acetate	3.6
Phenolic fiber	10	Cellulose acetate butyrate	3.6
Shellac	9	Polyamide	3.4
Vinyl chloracetate	6	Aniline-formaldehyde	3.3
Methyl methacrylate	6	Vinyl chloracetate	3.3
Aniline formaldehyde	2	Methyl methacrylate	3.0
Hard rubber	1	Hard rubber	3.0
Polystyrene	.05	Polystyrene	2.6

TABLE VI.—OTHER CONSIDERATIONS

Transparency	Fungus growth
Crazing	Welding characteristics
Cracking at inserts	Moisture content at time of molding
Unmolding	
Warping	Control of molding temperature and pressure
Stress release	
Resistance to common solvents	Supply of raw material
Resistance to light, humidity	Defense restrictions

Here's how your Plaskon



More and more, as the tempo of war production increases, Plaskon urea-formaldehyde resin is being used to serve the needs of our armed forces and its related operations.

The illustrations on the opposite page show only a few of these applications and indicate in a limited way the wide variety of uses to which Plaskon has been put.

In each of these cases, Plaskon offered special advantages which could not be found or readily adapted in other materials. Such features as strength, light weight, inertness, non-conductivity, economy and speed in manufacturing operations, are factors that make Plaskon an important wartime commodity.

Although the amount of Plaskon for civilian needs is greatly restricted, the Plaskon Company now is working with molders and manufacturers toward peace-time applications of this versatile plastic.

A new Plaskon research laboratory has just been opened. It is the most completely equipped laboratory in the industry, and is devoted exclusively to research in resins and plastics.

Behind its walls, inquisitive and persistent chemists and engineers are peering into the future—conducting pure research in the field of resins—seeking new plastics—new products—and new fields in which new plastics can be used.

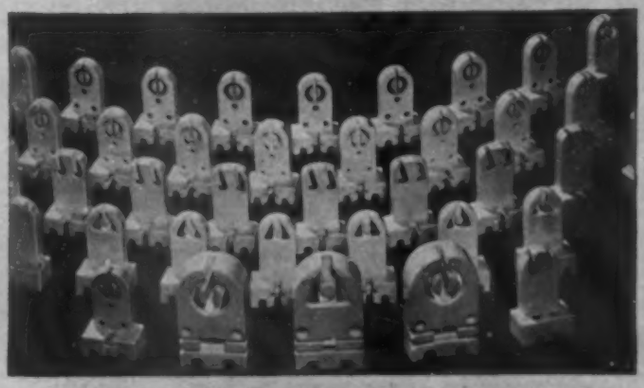
They are working closely with the designers, the production men, the sales managers of manufacturers in many widely differing lines.

Together, these men are developing new products, which they hope will fill new needs and later create new jobs when they are necessary. They are pointing toward a vastly different and more efficient world of tomorrow. Plaskon Company, Inc., 2121 Sylvan Avenue, Toledo, Ohio. Canadian Agent: Canadian Industries, Limited, Montreal, P. Q.

is Serving the Nation!

The Bristol Aircraft Corp., Bristol, Va., forms the Avro-Anson bomber nose with the aid of Plaskon Resin Glue.

Splitkein Flexible-Flyer Skis, made with the help of Plaskon Resin Glue, are in use by American troops. Made by S. L. Allen & Co., Inc., Philadelphia, Pa.



Molded Plaskon "tombstone" tube sockets for fluorescent lighting are helping production in the nation's great wartime armament program.

The Cochrane Surgical Window, molded of Plaskon by the Niagara Insul-Bake Specialty Co., Albany, N. Y., is used for the treatment of bomb wounds by the American Hospital in Britain.

Navy-type life rafts of great strength and resistance to destructive forces are being made with the help of Plaskon Resin Glue.

Micro-Switches of Plaskon are used for electrical controls in almost every plane aloft. Product of Micro-Switch Corp., Freeport, Ill. Molded by Richardson Co., Melrose Park, Ill.

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1380. Flame-shape, 18 mm. threaded cap, 7/8 in. high; measures 7/16 in. overall diameter

1381. Medium cap, 20 mm. threaded with decorated sidewall, 11/16 in. high; 15/16 in. diameter

1382. Fancy cap, 20 mm. medium, 3/4 in. high; 15/16 in. diameter

1383. Decorative conical 8 mm. cap, 3/4 in. high; 1/2 in. diameter

1384. Decorative conical 10 mm. cap, 3/4 in. high; 1/2 in. diameter

1385. Pointed 15 mm. cap with decorated sidewall; 15/16 in. high; 11/16 in. diameter; foil lined, threaded

1386. Tassel 10 mm. threaded cap with loop on top; 9/16 in. high; measures 9/16 in. overall diameter

1387. Tassel 8 mm. threaded cap with top loop. 9/16 in. high; measures 1/2 in. overall diameter

1388. Threaded 10 mm. cap, 3/8 in. high; 1/2 in. diameter

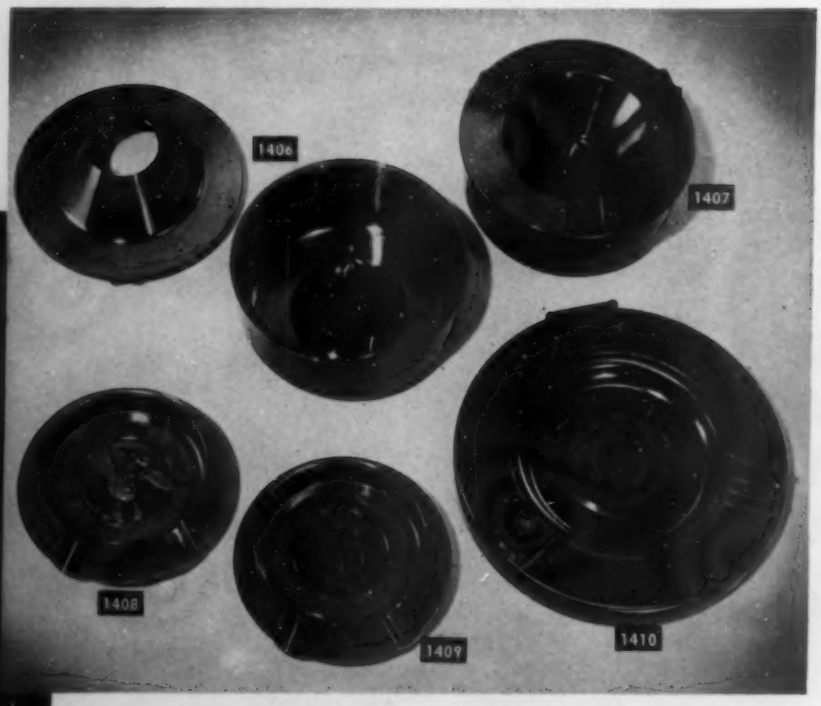
1389. Fancy 10 mm. threaded cap, 7/16 in. high; 9/16 in. diameter

1406-7. 2-piece ash tray with 3 deep V-shaped rests for cigarets. Diameter of top part 4 3/8 in.; diameter of base 4 3/8 in. Depth of base 1 3/4 in. By raising lid or top section ashes slide into lower part. (Separate parts are shown open at left)

1408–9. Ash tray with 2 rests for cigarets. Diameter 3 3/4 in.; 5/8 in. deep. By exchanging mold inserts, individual lettering or insignia may be had as in these two

1410. Shuffleboard disk ash tray with molded holder for either book or box matches. 2 sectional rests for cigarets or cigars. Customer's name or advertisement can be molded into center; 5 3/4 in. diameter, 3/4 in. deep

Note: Restrictions on supplies of raw materials may possibly limit production of some of these stock items. Please check with molders as to quantities available. — ED.



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All molders are invited to submit samples from molds to appear on this page as space permits

DR. GORDON M. KLINE, Technical Editor

Urea plastics in lighting fixtures

by R. BOWLING BARNES and CHARLES R. STOCK*

FAILURES of lighting fixtures fabricated of urea plastics can be avoided by proper design. The present investigation was undertaken to determine the limitations imposed by the properties of the plastic and to provide data on which proper design can be based.

Most frequent cause of failure of urea plastics in lighting service is that, in designing the fixtures, the effect of heat generated by the lamp is neglected. Excessive heating of the plastic causes discoloration and this affects its optical efficiency. The temperature of the plastic can be held within safe limits by designs based on three factors: The wattage of the lamp, and hence its heat output; the position of the lamp with respect to the molding, and hence the amount of heat reaching the plastic; and the size and shape of the molding, and hence its ability to dissipate heat reaching it. These factors are fundamental and must be given proper values on the basis of the resistance of the plastic to changes produced by heat.

The performance of the fixture in service depends upon the optical properties of the system of which it is a part: i.e., total light output; desired surface brightness; efficiency; diffusion required; and color. These characteristics are controlled by the design of the mold and by the composition of the plastic used. They are of necessity secondary to thermal considerations since stability of the molding to heat establishes the permanence of its optical properties in service.

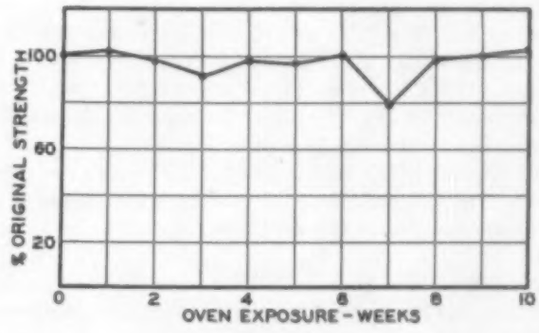
Effect of heat on plastics

Aging at room temperature over prolonged periods has no detectable effect on the strength of urea plastics. Although long exposure to elevated temperatures will ultimately weaken the plastic, ten weeks at 200 deg. F. caused no decrease in impact strength of a representative formulation (Fig. 1). Exposure to 250 deg. F. for a single week caused excessive browning of the sample but no considerable reduction in its strength. Thus it is apparent that the effect of high temperature on color is the controlling factor and not its effect on strength.

The effect on the plastic of heat from a lamp was determined by cutting a section from a sample exposed until it was scorched. When examined under the microscope, the discoloration was found to be confined to a thin layer on the surface of the section. Evidently the surface layer became considerably hotter than the interior of the sample, as expected from the relatively high resistance of the plastic to heat flow. This necessitated the development of an accurate method of measuring surface temperatures of the samples.

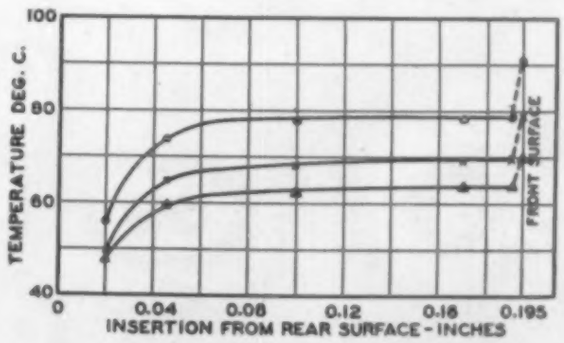
Both surface pyrometers and thermometers have been employed for measuring the temperature of plastics. Both instruments are unsatisfactory, primarily because their heat capacities are too great for measuring objects of low heat conductivity. Also, the surface pyrometer can usually be successfully applied only to the outside of the reflector, yielding, as shown in Fig. 2, values considerably lower than the temperature of the exposed surface. Moreover, these results vary with the thickness of the molding. Even the relative accuracy is only half that of thermocouple measurements of the front surface. A thermometer may be employed inside the fixture, but poor contact between the bulb and the reflector reduces the reliability of readings. In close quarters,

Fig. 1



1—Relative impact strength variation of representative molded plastic when exposed to 200 deg. F. in controlled electric oven for 10 weeks. Tests made weekly. 2—Temperature gradient in urea plastic, showing "skin effect" at the front surface and convection cooling at the rear surface

Fig. 2



* American Cyanamid Company, Stamford Research Laboratories.

too, the thermometer may be affected by direct radiation from the lamp.

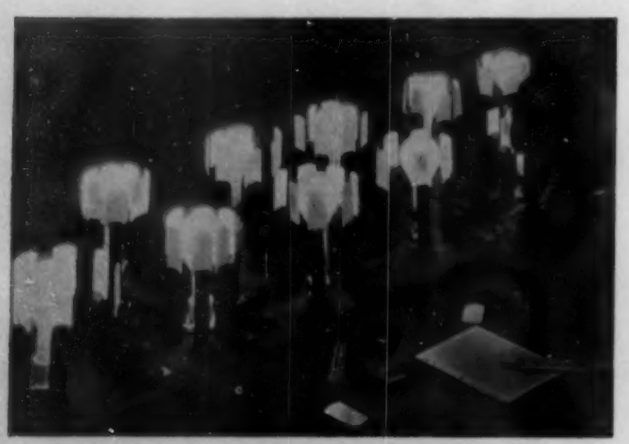
Measurement of surface temperature

In developing a more accurate method, thermocouples were inserted in test pieces in several different ways and then calibrated to find which was best (Fig. 3—A, B, C). Of the three methods shown, A was rejected because it could not be made reproducible and therefore had to be calibrated in each instance. Methods B and C were found to be reproducible and measured the temperature with sufficient accuracy to be satisfactory. Since C is less difficult to install than B, which requires countersinking a copper disk in the plastic, it was adopted for use in subsequent work. The thermocouples were calibrated by placing the test piece horizontally below a tungsten lamp and dusting its surface near the hot junction with organic crystals of known melting points. These small crystals were watched through a lens until those nearest the junction just reached the melting point. The thermocouple reading was then taken. This method of employing thermocouples gives an accuracy of ±2 degrees F. at 100 deg. F. above room temperature

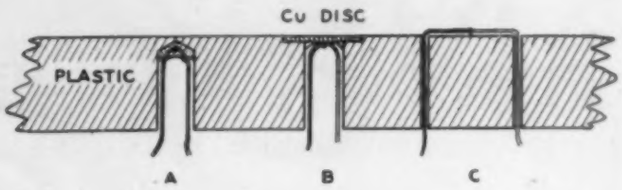
The tests of the effect of heat consisted of exposing seven samples of each of eight major types of urea plastic for 1100 consecutive hours to heat and radiation from 300-watt, 120-volt inside-frosted Mazda lamps at a constant potential of 120 volts. The seven samples were spaced at increasing distances from the lamp so that surface temperatures of 130 deg. to 200 deg. F. in 10-degree steps were obtained (Fig. 4). Inspection for discoloration was made weekly by comparison of the test pieces visually and spectroscopically with control samples of the same formulation protected from exposure. No marked difference was observable among comparable samples of the eight formulations. After an initial drop, the curves for 160 deg. and 170 deg. F. showed little change with increasing time. The curves for 180 deg. and higher showed a rapid progressive discoloration. This can be seen in Fig. 5—A, B, C and D, where original, 1000- and 2000-hr. color curves are reproduced. The value of 170 deg. F. was therefore chosen as the maximum safely allowable on the surface of a plastic luminaire.

The change in appearance of the samples was measured quantitatively by analysis of spectrophotometric color curves.

4—Heat test of urea plastic formulations to determine relation between time of exposure, temperature and degree of discoloration. Note scorched areas on overheated samples



These revealed that, on the average, each 13-degree rise in temperature in the probable range in lighting fixtures (130 deg.–210 deg. F.) reduced by half the time necessary to discolor the molding to an equal extent. Thus, samples exposed at 170 deg. for 1000 hours, to 183 deg. for 500 hours, to 196 deg.



3—Experimental methods of employing copper-constantan thermocouples to measure surface temperature

for 250 hours and to 209 deg. for 125 hours showed approximately the same slight change in appearance compared with the control. Apparently no critical temperature exists above which the plastic will discolor and below which it is safe.

Sources of discoloration

In order to trace the source of the discoloration, cast samples of pure urea-formaldehyde resin and sheets of alpha cellulose (the principal constituents of the finished plastic) were exposed separately to elevated temperatures and to ultraviolet radiation. Heat had no effect on the resin other than to produce crazing, probably because of vaporization of excess moisture present in the cast sample. This effect is absent in normal molding compounds made with alpha cellulose filler. Exposure of the resin to ultraviolet radiation, however, produced interesting results. A plate of the clear material was placed in an ultraviolet spectrograph in the position usually occupied by the photographic plate and the spectrum of an H-3 mercury arc was focused on it over a weekend. Although no changes in the exposed sample could be seen in visible light, an inspection in ultraviolet light showed bands of fluorescent yellow deterioration product wherever an emission band below an apparently critical value of 3130 Å had activated the material. This may be important in fluorescent lighting.

Pressed alpha cellulose, when exposed to heat, exhibited progressive discoloration and scorching of about the same degree and quality as shown by the molding material containing it. Exposure of the cellulose to severe ultraviolet radiation produced distinct yellowing of the same nature as that observed in the finished molding. The color change produced in urea moldings by continued exposure to elevated temperature or to ultraviolet radiation thus seems to occur principally through discoloration of the cellulose.

To determine whether ultraviolet radiation from a tungsten lamp would affect a urea plastic sample, several types of material were exposed to a lamp at a spacing which would normally elevate the front surface temperature to approximately 200 deg. F., but a strong air current was blown around the samples to maintain them close to room temperature. Spectrophotometric curves made of the samples after long exposure showed no change caused by ultraviolet radiation from the lamp in the absence of elevated temperature.

Temperature adjustment in the reflector

In determining lamp-to-reflector spacing a safety factor of 10 deg. F. is introduced to bring the maximum front surface

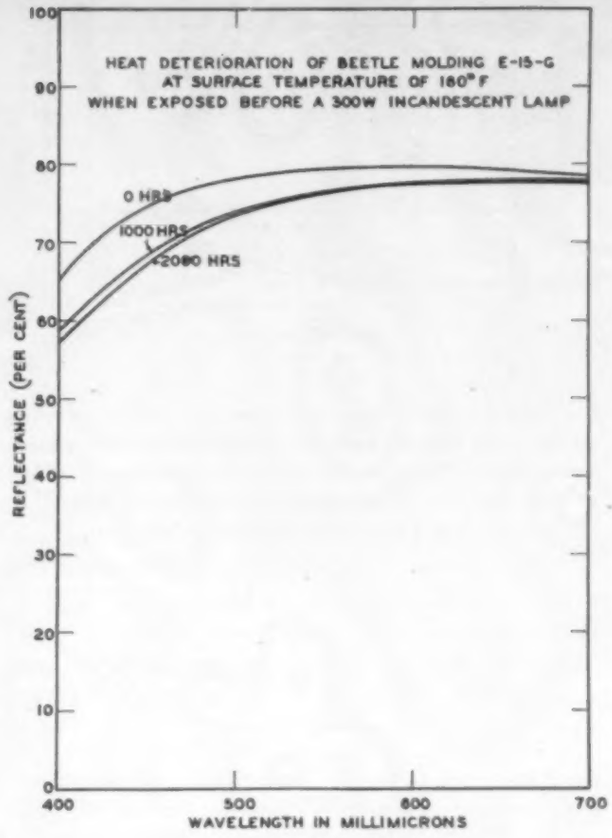


Fig. 5A

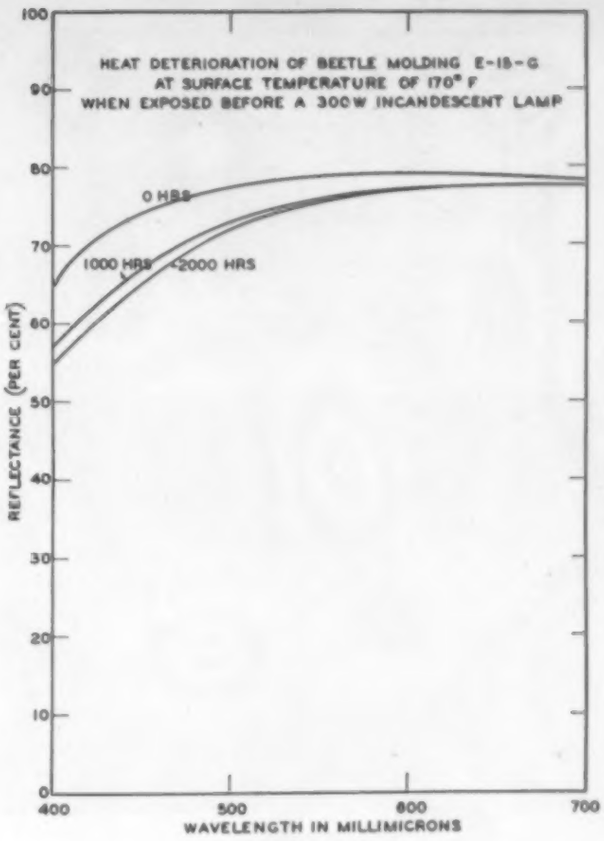


Fig. 5B

5 A, B, C, D—*Spectrophotometric curves of a sample of urea lighting material after increasing periods of exposure to* A—*160;* B—*170;* C—*180;* D—*190 degrees Fahrenheit from a 300-watt tungsten lamp*

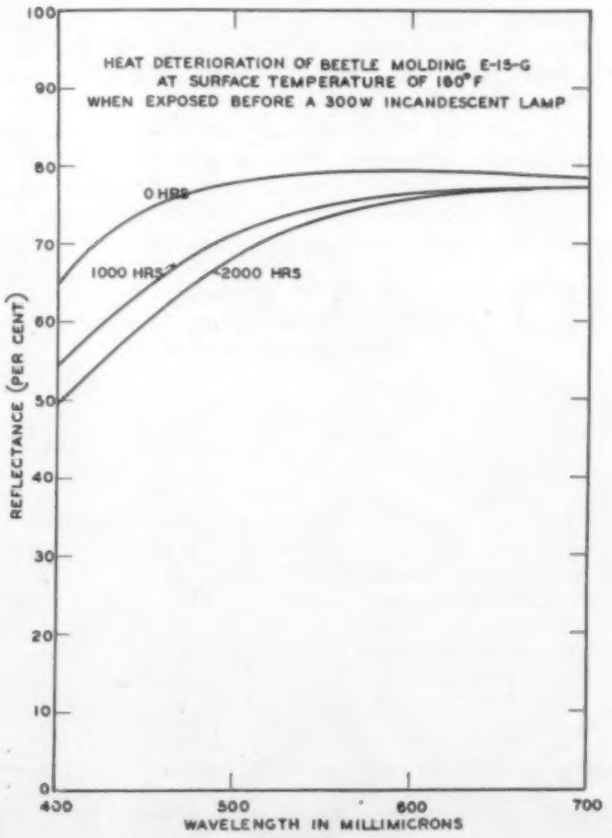


Fig. 5C

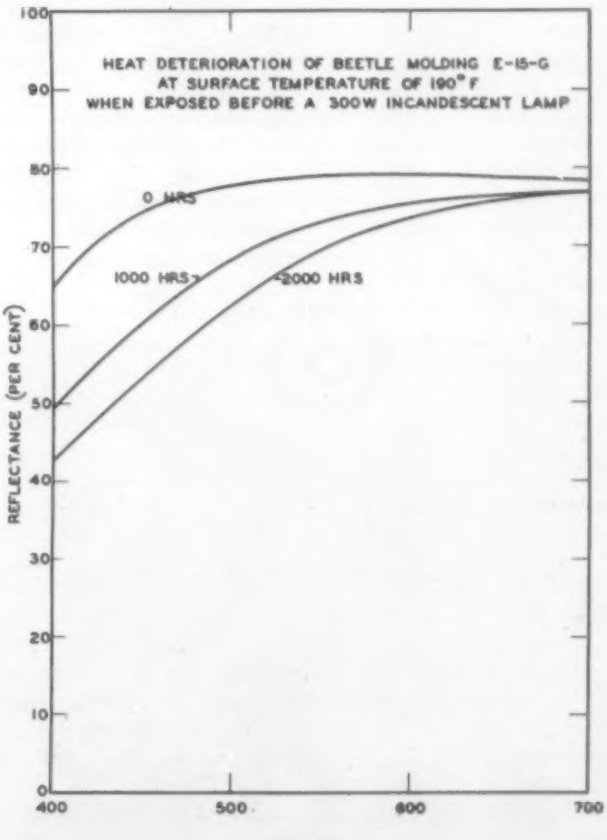

HEAT DETERIORATION OF BEETLE MOLDING E-15-G
AT SURFACE TEMPERATURE OF 190° F
WHEN EXPOSED BEFORE A 300W INCANDESCENT LAMP
0 HRS
1000 HRS
2000 HRS
REFLECTANCE (PER CENT)

Fig. 5D

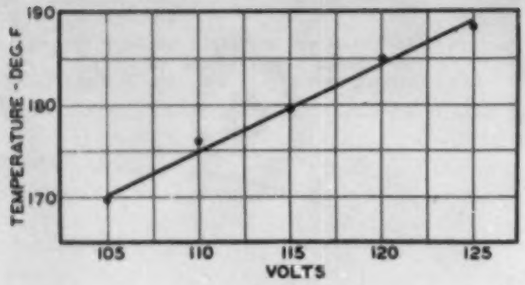


Fig. 6

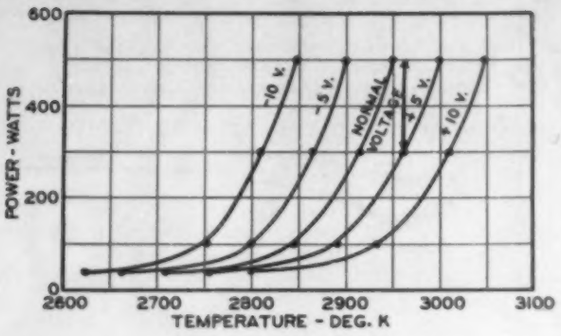


Fig. 7

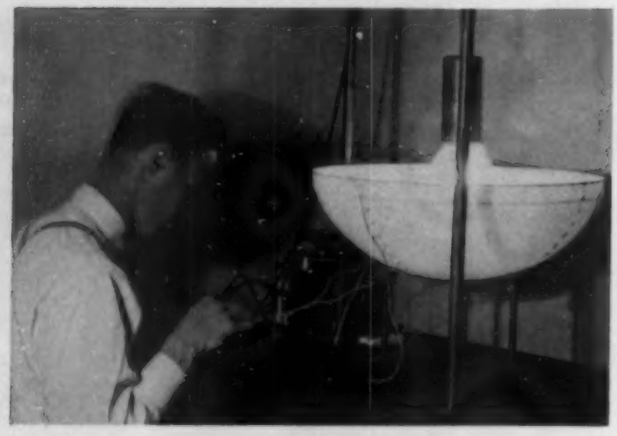


Fig. 8

6—Voltage-temperature relationship for varying lamp potential or for lamps of several voltage ratings at constant potential. **7**—*Temperature of tungsten filaments of various wattage lamps at under and over voltage. Forsythe & Adams tungsten filament incandescent lamp.* **8**—*Testing a plastic luminaire to ascertain correct spacing from lamp*

temperature of the plastic to 160 deg. F. This safety factor allows for departures from normal conditions which might cause overheating. One source of variation is fluctuation of voltage in the supply circuit known in some cases to depart from the modal potential by 10 volts or more. The other cause of trouble is the replacement of burned-out lamps with others of incorrect voltage rating. Investigation of the effect of these variables on the temperature of the reflector when spaced for normally safe operation shows (Fig. 6) that each volt increase in line potential or decrease in lamp rating changes the maximum temperature reached by the plastic by one degree Fahrenheit.

The change in temperature of a lamp filament with change in voltage for various wattage lamps is shown in Fig. 7. The curves show, for instance (arrow), that a 300-watt lamp filament operating at 5 volts over its rating has a temperature of 2960 deg. K., which is hotter by 10 deg. than that of a 500-watt filament at rated voltage. It can be seen, therefore, that the 10-deg. safety factor, under the worst possible combination of conditions, would compensate for only one-half of the temperature rise. The probability of the occurrence of this combination, fortunately, is not great. Moreover, since a regulated room temperature of 95 deg. F. was employed for all temperature tests here described, the probability of exceeding 170 deg. F. is still further reduced, for room temperature seldom reaches this value in service. Lower room temperatures cause an equal drop in reflector temperature, and this will reduce still further the operating temperature of the fixture, thus lengthening its life expectancy by another large factor.

Figure 8 shows a typical reflector bowl being tested to determine the lamp-to-reflector spacing for a maximum temperature of 160 deg. F. on the inside surface. The lamp was moved upward along the axis by small increments, and measurements were made at each position. If the shape of the bowl does not depart too greatly from a section of a sphere, the hottest area is usually found where a radius from the lamp filament 15 deg. from the vertical meets the plastic surface. The radiation distribution for a bare lamp and the shape of the molding combine to produce this maximum.

The data from the procedure shown in Fig. 8 give smooth curves of temperature maxima versus corresponding lamp-to-reflector spacings. From these, correct interpolations may be made. Figures 9 and 10 show curves for two reflectors, the first having a diameter of 21 in. and a depth of $7^1/_4$ in., and the second, $16^1/_2$ by 6 inch. Figure 11 shows curves for a $15^1/_2$ in. reflector of $5^1/_2$ in. depth. The effect of change in dimensions of the moldings can be seen from Figs. 10 and 11.

Ventilation plays an important part in maintaining low temperature. Convection currents sweeping over the lamp and the inside surface of the reflector carry away large amounts of heat. To take fullest advantage of these air currents, reflectors are usually made shallow. An alternative is

TABLE I. DIFFUSING POWER OF GLASS, CLOTH AND UREA PLASTIC BY TRANSMITTED LIGHT

Material[a]	Thickness, in.	Transmission, percent	Diffusing power[b]
Alabaster glass	.245	50.5	50
Monax glass (matt)	.241	21.5	85
Monax glass (plane)	.241	22.0	85
Hammered glass (rough)	.257	81.0	4
Hammered glass (plane)	.257	79.0	5
Sand blasted glass (rough)	.126	66.5	16
Sand blasted glass (plane)	.126	63.5	16
Window shade cloth	.008	20.0	85
Plastic 8070	.050	43.5	80
Plastic 245	.050	12.5	88

[a] "Rough" and "plane" indicate side of sample upon which light was incident.

[b] "Measurement of Diffusion." I. E. S. Progress Report of Sub-Committee on Diffusion of the Committee on Characteristics of Illuminating Materials. Aug. 29, 1938.

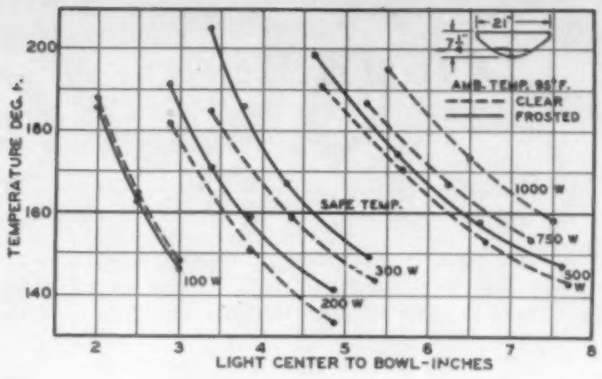


Fig. 9

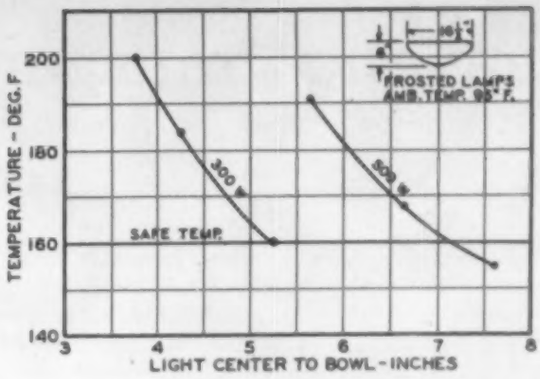


Fig. 10

9—*Temperature-spacing relationship for 21 by 7¼-in. reflector, using clear and frosted lamps at rated voltage.*
10—*Temperature-spacing curves for 16½ by 6-in. reflector.*
11—*Temperature-spacing curves for 15½ by 5½-in. reflector*

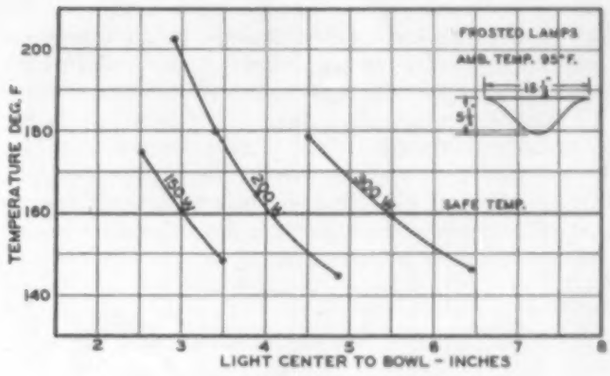


Fig. 11

to place a decorative louver in the bottom of the reflector. This modification produces a chimney-like draft past the lamp, removing heat from the source. Radiant energy reaching the plastic can be reduced only by wider spacing.

In designs which do not permit ventilation (such as a molding which completely encloses the lamp), care must be taken to allow for the absence of convection cooling. The low heat conductivity of urea molding materials makes a fixture of this type in effect an electric oven, and therefore likely to scorch. A proposed design of this type should be constructed out of wood, heavy bristolboard or similar poor conducting medium and tested for its maximum temperature with lamps of several wattages to ascertain the size of lamp that can be safely used with the molding.

Control of optical properties

The major optical function of the glass-like resin is to provide a medium of the correct refractive index to mask discrete cellulose fibers and at the same time to give the molded surface a uniform appearance while allowing light to be scattered by the cellulose filaments. The difference between the indices of refraction of resin and opacifying pigment is also important since this establishes the scattering power of the pigment and therefore, indirectly, the efficiency of the material. The refractive index of the molded urea resin is close to 1.57 (in the range of light flint glass).

Diffusion

Cellulose (refractive index 1.54) produces a large part of the diffusing power which makes urea plastics desirable for semi-indirect luminaires. A photomicrograph of a section through a molding (Fig. 12) shows clearly how the fibers are scattered throughout the resin, causing inhomogeneities which diffuse the light. Table I indicates how two grades of molded urea material, one translucent and the other more opaque, compare with other standard materials with respect to diffusing power.

Surface brightness

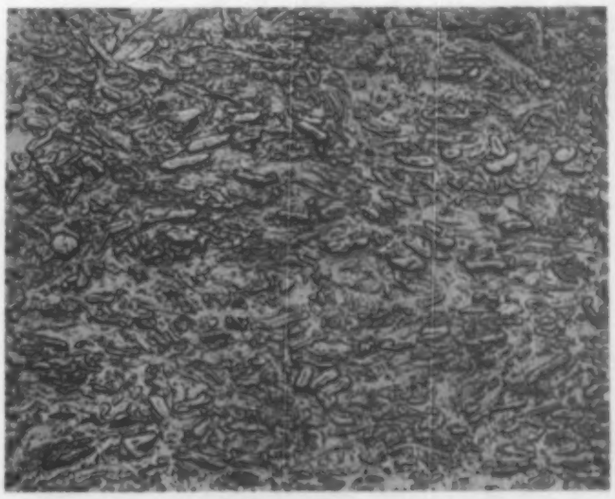
The surface brightness of a fixture, measured in candles per square inch, must be considered in some detail because of its importance to vision and to the appearance of the molding in operation. It is controlled by three variable conditions: The intensity of the incident light; the angle of incidence of the rays on the surface; and the portion of total incident light transmitted. The dependence of surface brightness upon these three variables is expressed by Equation 1.

$$B = kTI \cos a,$$

where B = surface brightness, T = transmission factor, I =

(*Please turn to page 96*)

12—*Photomicrograph of section through molded urea plastic, showing cellulose fibers dispersed in the resin. Resin-fiber interfaces scatter incident light, making material highly diffusive. Magnification 250×*



Drawing transparent containers

by H. K. HAVILAND*

THE popularity of the "individual show case" or transparent container has stimulated considerable interest in the drawing or swedging process of forming certain types of container from transparent thermoplastic sheet materials. In general, the process of drawing thermoplastic sheets is somwhat similar to that of drawing sheet metal, except that a heated die is used to make the material soft and plastic. Die-cut blanks of proper shape are placed on a heated die plate; a cool plunger or shaped former draws the material into the die and stretches it so that it forms tightly around and takes the shape of the former. A hold-down or pressure plate holds the blank on the die and controls the smooth drawing of the material into the die and around the former. At the end of the downward stroke of the plunger the formed piece is sheared from the flange that remains between the hold-down and die plates. The piece is then removed from the former by stripper fingers or is blown off by compressed air as the plunger is returned to the starting position.

Types of container

Transparent and translucent containers and displays of various shapes such as cylindrical, rectangular, hemispherical irregular, slip-over covers, etc., can be made by drawing.

Materials

The materials used are of the thermoplastic type—that is, they become soft and stretchable when heated and set or harden again when cooled. The types of plastics most commonly used for this application are cellulose acetate, ethylcellulose and vinyl copolymer resin. These materials are available in sheet or roll form in thicknesses from 0.005 in. to 0.020 in.

*Plastics Div., Celanese Corp. of America, formerly Celluloid Corp.

Equipment

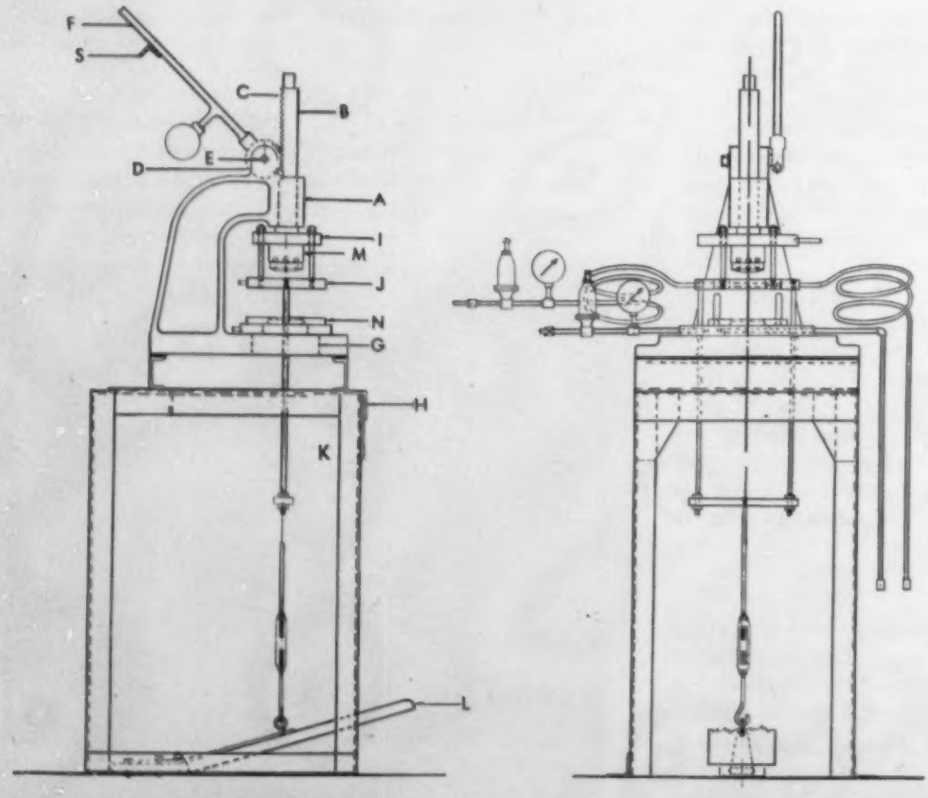
The essential pieces of equipment for drawing containers consist of (a) chop-out press, (b) chop-out dies, (c) forming press and (d) forming dies.

Chop-out press: The usual chop-out press is a straight column, double-crank press with an adjustable table on which sheets are stacked to be blanked out.

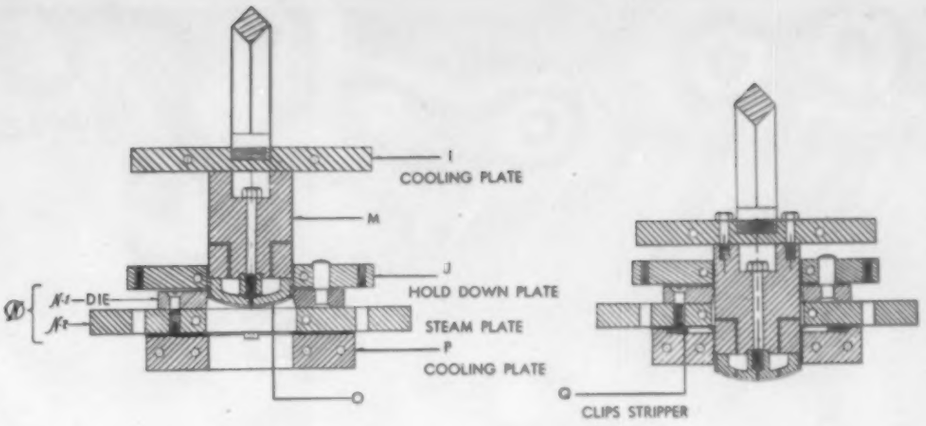
Chop-out dies: Chop-out or dinking dies are made of steel with a cutting edge shaped to the profile of the blanks to be cut.

Forming press and die: Forming presses are either manually operated or automatic. The hand press is the most common; one type is shown in Fig. 1. As the press and die are operated as a unit, they will be described together.

The press itself consists essentially of a C-shaped casting *A*, at the upper extremity of which is a rectangular opening in which the plunger rod *B* can be reciprocated. The plunger rod is made of this shape for ease of take-up under wear and for aligning purposes. On one side of this rod a rack is cut at *C* which engages with the partial pinion *D* pivoted on center *E* and operated by the counterweighted lever *F*. The base plate of casting *A* has a hole *G* larger than the maximum dimensions of the piece which it is desired to make. The entire press may be mounted on any type of table or frame-



1—Diagrammatic view of a hand-operated forming press which is operated as one unit with a die. This is typical equipment used in drawing or swedging of thermoplastic sheet materials into various shapes



2—*Typical forming die used in drawing thermoplastic material. Each die is different since its exact design necessarily depends upon the contours of the plastic piece it is intended to form*

work *H* at a reasonable distance from the floor to permit a standing operator to operate the press. At the bottom of plunger *C* a plate *I* is fastened which acts as a support for the die and its appertaining parts. To a portion of the die *J* is fastened a rod *K*, operated by a foot pedal *L*. The function of this rod and foot pedal is not only to bring down the plate *J* by means of foot pressure, but also to draw forward within the operator's reach the operating lever *F* which normally, because of its counterweighted condition, will topple over and out of reach of the operator when the press is open. From the plate *I* is suspended the die plunger *M*, properly designed to form the shape desired, and the pressure plate *J* referred to above. The base plate of the press carries the lower portion of the die *N*.

The die itself can be only generally described since its exact design depends upon the piece which it is desired to form. A typical die is shown in Fig. 2. The plunger consists of the "former" *O*, shaped to the exact contour and dimensions of the desired finished piece. This portion is made separable from the portion *M* which is slightly larger. The hold-down plate *J* has an opening slightly larger than the plunger *M* to permit it to slide very freely therein. The die plate *N* is composed of two portions *N-1*, the die plate proper, and *N-2*, a steam-heated plate. The die plate *N-1* is made to a size such that it will be equal to the outside dimensions of the finished piece, with proper clearance, and is beveled away from the front edge as shown. The upper edge of the die plate *N-1* forms the so-called shear-off point. As the plunger *M* is forced through the die plate it shears the stock off to complete the piece. Below the heating plate *N-2* and separated therefrom by a layer of asbestos insulation, is a so-called cooling plate *P* over which are mounted stripping fingers *Q* to remove the finished piece from the former O.

In the process of drawing, there is a tendency to entrap air between the stock and the former which would prevent the proper formation of the stock. To permit the air to escape, the former *O* is perforated with not less than seven holes approximately 0.015 in. in diameter. One of these holes should be in the center and the others distributed uniformly about $^1/_2$ in. away from the perimeter of the formed piece. The holes are purposely made very small to prevent marking the stock, but to render them more effective they should be relieved on the inside of the former by enlarging them to approximately $^1/_8$-in. diameter. The point of escape should be through the portion *M* above the cut-off edge.

Another type of hand press and forming die is shown in Fig. 3. In principle it is similar to the unit described above. The foot pedal operating the hold-down plate is not shown in the drawing. Instead of stripper finger to remove the finished piece, compressed air is used to blow the piece off the former at the end of the downward stroke of the plunger.

The cut-off arrangement of the die is somewhat different and is shown in detail in the enlarged sections *CC* and *DD* of Fig. 3. The upper or leading edge *34* of die plate *3* is slightly rounded while the lower corresponding edge *35* of the cut-off member *23* is a sharp right angle corner. As the corner *35* is a right angle corner and protrudes slightly over edge *34* which is rounded, they will always meet in a line contact on the rounded edge of *34* irrespective of the normal expansion and contraction of the parts *3*, *22* and *23* due to temperature adjustments which may be necessary in drawing. As the die *3* is heated and in view of the pressure exerted between the cut-off member *23* and the die, the stock being formed will be subjected to heat and pressure along a line of contact, thereby severing the stock by a molding operation along that line producing a heat-sealed, tear-resistant edge. A sharp clean cut-off is absolutely dependent upon maintaining this line of contact between cut-off member and the die. The edge *35* may be kept sharp by periodically trueing-up or squaring-up this edge on a surface grinder. The edge *34* of the die may be made sharp and then rounded off by taking off about 0.01 in. of the metal.

Materials for metal parts

The materials to be used for the important parts of the die and former are as follows:

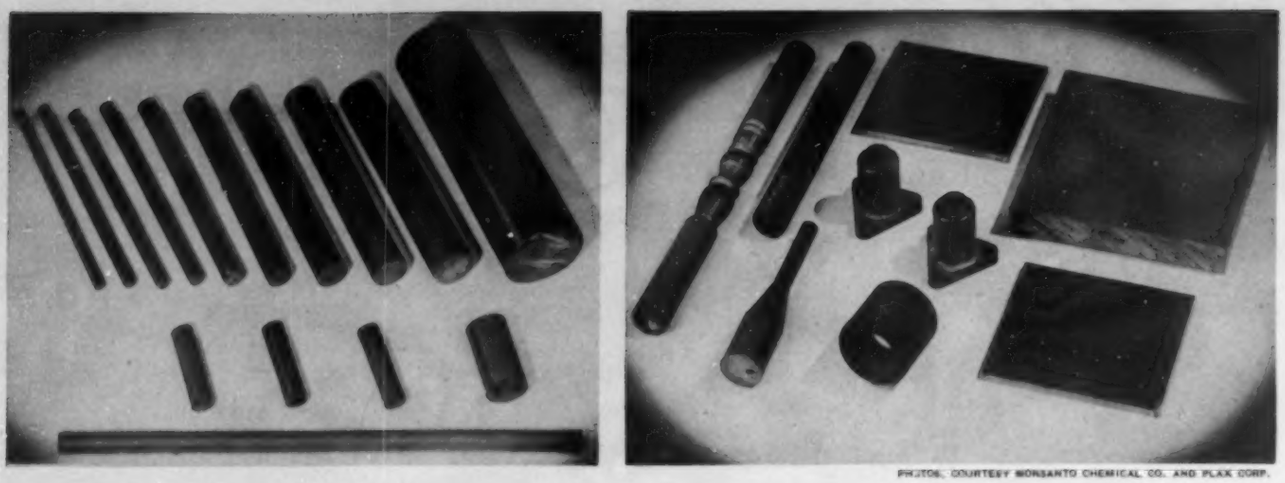
Former and hold-down plate—Machine steel of 0.25 to 0.35 percent carbon.

Die plate and cut-off member—Oil hardened tool steel, hardened to 60 or higher Rockwell C.

Sizes and clearances

The dimensions of the former are equal to the inside dimensions of the container to be made. The former is tapered approximately 0.003 in. per inch of depth to facilitate stripping the finished piece from the former. The clearance between the top of the former and the opening in the die plate is equal to the thickness of the stock plus about 0.002 in. to 0.005 in. at the operating temperature of the die and former. Corners of the former, such as the junction of the bottom and side walls, should be rounded usually to not less than $^1/_{16}$ in. radius. Multi-sided containers should have a radius in the corners of not less than $^3/_{16}$ in. Sharp corners cannot be made without danger of tearing the stock.

The opening in the hold-down plate is liberally clear and usually about $^1/_{32}$ in. larger than the dimensions of the cut-off member. The cut-off member, if of the shearing type shown in Fig. 2, should be of such size (*Please turn to page 104*)



PHOTOS, COURTESY MONSANTO CHEMICAL CO. AND PLAX CORP.

Series of standard rods and tubes and some miscellaneous shapes made from Styramic

Styramic for high frequency insulation

by T. S. CARSWELL and R. F. HAYES*

THE most widely used insulation for radio apparatus and similar equipment which employs high frequency currents has been of a ceramic nature, and has consisted either of porcelain or of a combination of mica fused together with a low-melting glass. This ceramic insulating material has been quite satisfactory although, like all materials, it has both its weak and its strong points. Among the strong points are resistance to high temperatures, relatively low water absorption and non-flammability. Among its weak points are slightly inadequate electrical characteristics at high frequencies, high cost of individual pieces, poor machinability and difficulty in maintaining close tolerances.

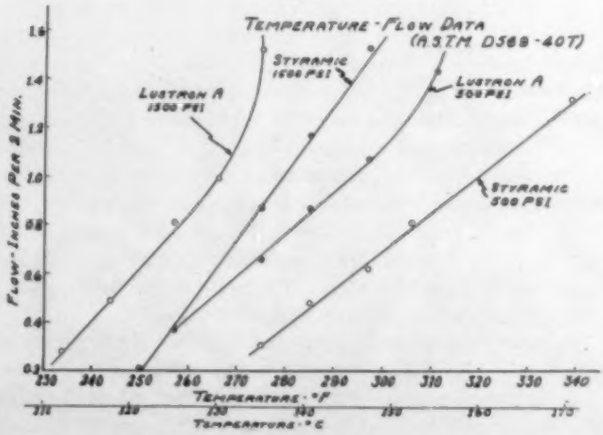
It was obvious that polystyrene offered some advantages over the ceramic materials in this field. The dielectric constant and power factor of polystyrene are unsurpassed at high frequencies, and polystyrene has negligible water absorption. However, polystyrene suffers from two major defects: the softening point is rather low for many of the applications, and polystyrene itself burns readily.

Research work was undertaken to develop a readily available modification of polystyrene which would overcome these deficiencies. The early work was concerned with the study of inorganic fillers such as mica, quartz and powdered glass. All of these showed poor high frequency insulating properties, particularly after water immersion. The work finally narrowed down to a combination of polystyrene with chlorinated diphenyl of the Aroclor** type. By selection of the proper type of chlorinated diphenyl, it was possible to get a molding material which showed improved heat resistance, complete non-flammability and excellent electrical characteristics over very wide frequency ranges. The material can readily be molded by injection or compression; and since the molded pieces contain less residual internal stress than polystyrene itself, they can stand higher temperatures without unmolding or distorting. The material can also be extruded into rods, tubes or other shapes of uniform cross section. Owing to the fact that it can be injection molded, parts can be fabricated in quantity at a price less than that of ceramics. At the same time, the material has excellent machinability and can be readily drilled, tapped or turned where this is necessary to supplement molding.

The trade name Styramic** has been given to this material. In Table I data are presented to show the *physical properties* of the chlorinated-diphenyl-polystyrene compound as compared to those of Lustron–A,** a commercial grade of polystyrene. The data presented were in practically every case obtained by the standard methods of the American Society for Testing Materials, and reference to the exact A.S.T.M. method employed is given in the table.

Table II shows the *mechanical properties* of the chlorinated-diphenyl-polystyrene compound as compared to those of polystyrene. These data have been obtained by using both

Fig. 1



* Plastics Div., Monsanto Chemical Company.
** Trademark reg. U. S. Pat. Off.

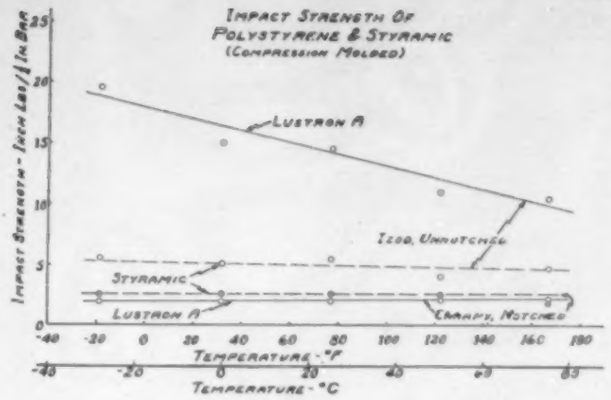


Fig. 2

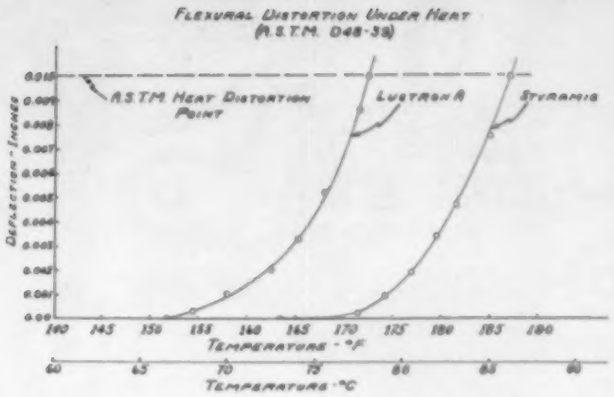


Fig. 3

compression molded and injection molded bars, and all of the tests were run at 25 deg. C. and 50 percent relative humidity.

The *electrical insulating properties* of the chlorinated-diphenyl-polystyrene compound as compared to those of polystyrene and various other insulating materials are given in Table III. In the case of polystyrene and the chlorinated-diphenyl-polystyrene compound, the data have been obtained either in our own laboratories or through cooperation with the Westinghouse Electric & Manufacturing Company. The data for many of the other materials have been taken from various places in the literature. An examination of Tables I and III shows that the chlorinated-diphenyl-polystyrene compound and polystyrene have much better high frequency electrical characteristics than other commonly used insulating materials.

Figure 1 presents Rossi-Peakes *flow data* at various temperatures as obtained by A.S.T.M. method D569–40T. It will be observed that the chlorinated-diphenyl-polystyrene compound requires a higher temperature for equivalent flow than the particular grade of polystyrene with which it is compared. However, the flow is not greatly inferior to that of polystyrene, and experiments have shown that it has excellent moldability.

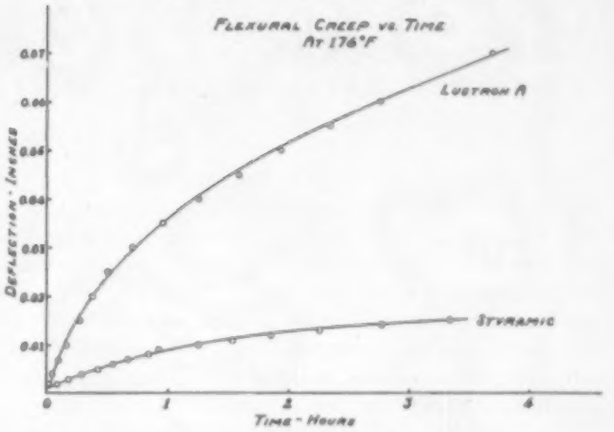


Fig. 4

Figure 2 shows the *impact strength* of the chlorinated-diphenyl-polystyrene compound as compared to polystyrene over a wide range of temperatures. It will be observed that the unnotched chlorinated-diphenyl-polystyrene compound is materially lower in impact strength than the unnotched

TABLE I.—PHYSICAL PROPERTIES* OF STYRAMIC AND LUSTRON

Property		*Molding Method*	*Test Method*	*Styramic*	*Lustron A*
Specific gravity, 25/25° C.		C	.....	1.358	1.049
Specific volume, cu. in./lb.		C	.....	20.45	26.42
Mold and age shrinkage, 6 months, in./in.		I	.....	.0025	.0024
Heat distortion temperature		C	A.S.T.M. D48-39	84.5-86° C. 184-187° F.	76-78° C. 168-172° F.
Flow temperature		..	A.S.T.M. D569-40T	138° C. 280° F.	130° C. 266° F.
Water absorption, 24 hr., %		C	A.S.T.M. D570-40T	.046	.078
Burning rate, in./min.		..	A.S.T.M. D635-41T	Chars slightly but will not burn	.77
Dielectric constant, 300 kc.:	Dry,	C	A.S.T.M. D150-39T	2.55	2.60
	96 hr. water immersion,	C	A.S.T.M. D150-39T	2.60	2.60
Power factor, 300 kc.:	Dry, %	C	A.S.T.M. D150-39T	.04	<.03
	96 hr. water immersion, %	C	A.S.T.M. D150-39T	.04	<.03
Loss factor, 300 kc.:	Dry, %	C	A.S.T.M. D150-39T	.1	<.08
	96 hr. water immersion, %	C	A.S.T.M. D150-39T	.1	<.08

C = Compression molded. I = Injection molded. All tests run at 25° C. and 50 percent relative humidity unless otherwise stated.

* Based on original work by the Plastics Div., Monsanto Chemical Co., and a private communication from the Westinghouse Electric & Manufacturing Company.

TABLE II.—MECHANICAL PROPERTIES* OF STYRAMIC AND LUSTRON

Property		*Molding Method*	*Test Method*	*Styramic*	*Lustron A*
Tensile strength, p.s.i.		I	A.S.T.M. D638–41T (2)	3240	6160
Elongation, %		I	A.S.T.M. D638–41T (2)	0.97	1.94
Flexural strength, p.s.i.		I	....	6540	13,100
Deflection at break, in.		I	....	0.032	0.116
Compressive strength, p.s.i.:	Yield	C	Army Air Corps	11,300	12,550
	Ultimate			11,400	10,800
Compressive strain, %:	Yield	C	Army Air Corps	4.1	4.5
	Ultimate			45	43
Young's modulus, p.s.i. × 10^{-5}:	In tension	I	....	3.34	3.18
	In compression	C	....	4.02	3.85
Impact strength, in.-lb./bar:	Izod, unnotched	C	A.S.T.M. D256–41T	5.7	14.5
	Charpy, notched	C	(modified)	2.5	2.2
Rockwell hardness		C	A.S.T.M. E–18–36	M-72	M-89

C = Compression molded. I = Injection molded. All tests conducted at 25° C. and 50% relative humidity.

* Original work, Monsanto Chemical Co., Plastics Div.

polystyrene. The notch-sensitivity of the chlorinated-diphenyl-polystyrene compound seems to be somewhat less than that of polystyrene, and the notched bars have virtually equivalent impact resistance. Parallel tests on ceramic and chlorinated-diphenyl-polystyrene compound bars indicate that the impact resistance of ceramic is also of a low order, and averages about one-half that of the chlorinated-diphenyl-polystyrene compound.

As has previously been indicated, one of the most important objectives in developing the chlorinated-diphenyl-polystyrene compound was the production of material having better *heat resistance* than is exhibited by polystyrene. It may be seen from Table I and Fig. 3 that the A.S.T.M. heat distortion temperature of the chlorinated-diphenyl-polystyrene compound is approximately 15 degrees F. higher than that of polystyrene. Figure 4 plots the flexural creep at 176 deg. F. (80 deg. C.) as a function of time for the chlorinated-diphenyl-polystyrene compound and polystyrene. These data were obtained on a $^1/_2$ in. by $^1/_2$ in. compression-molded bar under a load of 2.5 kg. using an A.S.T.M. D48–39 heat distortion apparatus that had been equipped with a thermoregulator so that constant temperatures could be maintained. Figure 5 plots rate of plastic flow as a function of temperature for the chlorinated-diphenyl-polystyrene compound and polystyrene. The rate of plastic flow was determined from that portion of the flexural creep curve where the rate of flow was relatively constant. These data together with the other data on heat resistance indicate that the chlorinated-diphenyl-polystyrene compound may be used at temperatures approximately 15 degrees F. higher than those which are safe for polystyrene, and that the maximum operating temperature, for molded pieces of a (*Please turn to page 108*)

TABLE III.—PROPERTIES* OF ELECTRICAL INSULATING MATERIALS

Material	*Specific Gravity*	*Tensile Strength, p.s.i.*	*Dielectric Constant*	*Power Factor* 60 C.	1 Kc.	1 Mc.	*Machinability*
Polystyrene	1.05	6000–7000	2.6	.02	.02	.02	Good
Styramic	1.36	3000–3500	2.6			.04 (300 Kc.)	Excellent
Mycalex	3.5	6000–8000	6–8		.6	.3	Poor
Steatite	2.5	8000–10,000	6.1	1	.4	.3	Very poor
Porcelain (dry process)	2.3	2000–3000	6.2–7.5	2	1.	.7	Very poor
Mica	2.8		7.0–7.3	.03	.02	.02	Poor
Quartz (fused)	2.21	7000–10,000	4.2	.03	.03	.03	Very poor
Glass, Pyrex	2.25		4.5		.5	.2	No
Hard rubber	1.15	4000–7000	2–3	1	1.	.5 –.9	Fair
Slate	2.8	5000	6–8		.9		Fair
Cellulose acetate	1.3	3500–10,000	3.5–6.4	.01–.06	.01–.06	.01–.05	Excellent
Cellulose nitrate	1.35	5000–10,000	6.7–7.3	.06–.15		.07–.10	Excellent
Urea-formaldehyde	1.45	5000–7000	7.6–8.6	.04–.06		.03–.04	Good
Phenol-formaldehyde:							
Pure	1.28	6000–9000	5–6	.05–.1	.02–.06	.02–.04	Good
Wood filler	1.25–1.5	4000–11,000	5–12	.04–.3	.04–.15	.03–.1	Good
Mineral filler	1.6–2.0	4000–10,000	5–20	.1 –.3	.1 –.2	.005–.1	Fair
Fabric filler	1.3–1.4	6500–8000	5–10	.08–.3	.08–.2	.04–.1	Good
Polymethyl methacrylate	1.19	7000–9000	3.5	.06	.06	.025	Good

* References
1. General Radio Experimenter, XIV, June 1939.
2. Original work, Monsanto Chemical Co., Plastics Division.
3. Plastics Properties Chart, MODERN PLASTICS CATALOG, 1941, page 150; cf. MODERN PLASTICS CATALOG, 1942, page 184.
4. Private communication, Westinghouse Electric & Manufacturing Company.

Respirator filter holders and valves molded by Sobenite, Inc., for H. S. Cover

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TENITE respirator parts serve to protect the wearer against inhaling dust, light fumes and vapors. They replace aluminum and are said to be less expensive to manufacture, easier to assemble, and more comfortable to wear.

Excellent molding properties, high impact strength, dimensional stability, and light weight make Tenite the engineers' choice among plastics for this application. Tenite has the further advantages of being washable and impervious to perspiration.

Welding goggles, helmets, instrument housings, oil cups, and electric light lenses are some of the many safety and protective devices for which Tenite is now used. A 28-page illustrated book on the properties and uses of this plastic will be sent on request.

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Kingsport, Tenn. *Subsidiary of Eastman Kodak Co.*

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Deformation of plastics under load

Scope

1. (*a*) This method of test covers the procedure for determining the deformation of plastics under compression of nonmetallic sheet and molded materials, of all classes and all commercial thicknesses, intended for structural and insulating purposes.

(*b*) The word deformation is used herein in the broad sense to cover (1) dimensional change due almost entirely to flow, and (2) dimensional change due to a combination of flow and shrinkage caused by loss of water or other volatile matter. Methyl methacrylate and polystyrene are examples of materials that deform almost entirely by flow. Cellulose acetate, cellulose acetate butyrate, phenol fiber, and vulcanized fiber are examples of materials that deform by a combination of flow and shrinkage.

Nature of test

2. The principle of the method is essentially that of the parallel plate, namely, a constant force system whereby a test specimen is conditioned, if necessary, and is then placed between the parallel plates of a constant force device and the change in thickness is observed over a period of 24 hr. at a temperature of 50 deg. C. (122 deg. F.), unless otherwise specified.

Apparatus

3. The apparatus shall consist of the following:

(*a*) *Testing machine.*—A machine capable of exerting a constant force of 1000 lb. ± 1 percent between the parallel anvils of the machine, which shall be arranged so that they can be brought into contact with the test specimen before the load is applied. A machine suitable for this test is shown in Fig. 1. One of the anvils of the machine shall preferably be self-aligning and shall, in order that the load may be applied evenly over the face of the specimen, be arranged so that the specimen is accurately centered and the resultant of the load is through its center. The machine shall also be equipped with a dial gage or the equivalent capable of measuring the relative movement of the faces to 0.001 in. or less.

(*b*) *Test chamber.*—A test chamber of suitable size and construction to enclose the testing machine and maintain it at 50 ± 0.5 deg. C. (122 ± 1 deg. F.) during the test except for the short period at the beginning when opening the door may cause a drop in temperature.

(*c*) *Preconditioning oven.*—An oven for preconditioning the test specimens at 65 ± 3 deg. C. (150 ± 5 deg. F.) for 4 hours.

(*d*) *Conditioning chamber.*—A chamber for conditioning, capable of maintaining a relative humidity of 90 ± 2 percent at a temperature of 35 ± 1 deg. C. (95 ± 2 deg. F.) for 68 hours.

Test specimens

4. (*a*) The test specimen shall be a $^1/_2$ in. cube, either solid or composite. Materials over $^1/_2$ in. in thickness shall be reduced to $^1/_2$ in., and thinner materials shall be piled up with the total height as near to $^1/_2$ in. as possible. The squares of the composite specimen shall be accurately aligned in all cases. Specimens made from the standard $^1/_2$ by $^1/_2$ by 5-in. test bar shall be tested in the direction of molding.

(*b*) The specimens for materials made in large sheets, such as phenol fiber, where moisture absorption characteristics may vary over the entire surface, shall be prepared in accordance with (*Please turn to page 112*)

* The above proposed tentative method of test for deformation of plastics, under load at elevated temperatures, A.S.T.M. designation D 621-41 T is published here by permission of the American Society for Testing Materials.

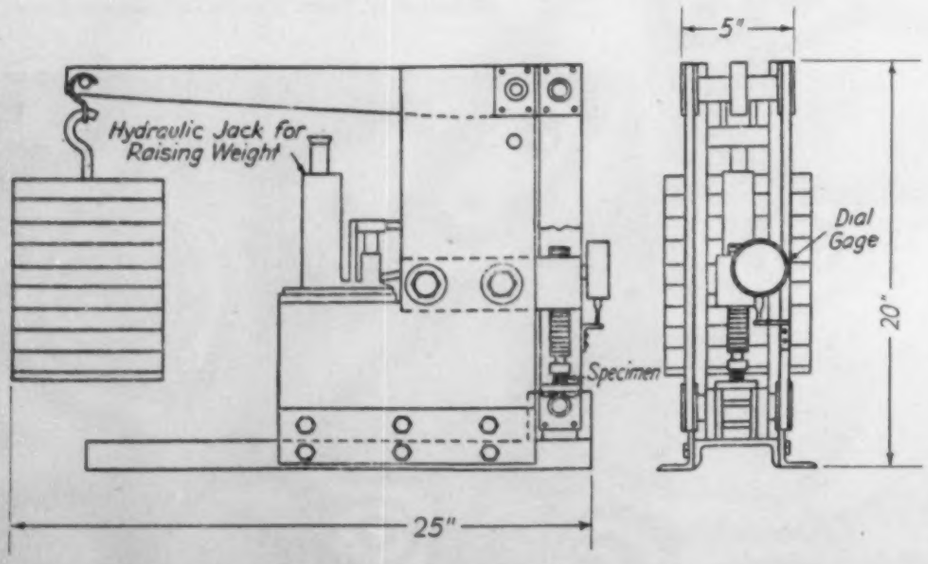

Fig. 1—Deformation testing machine

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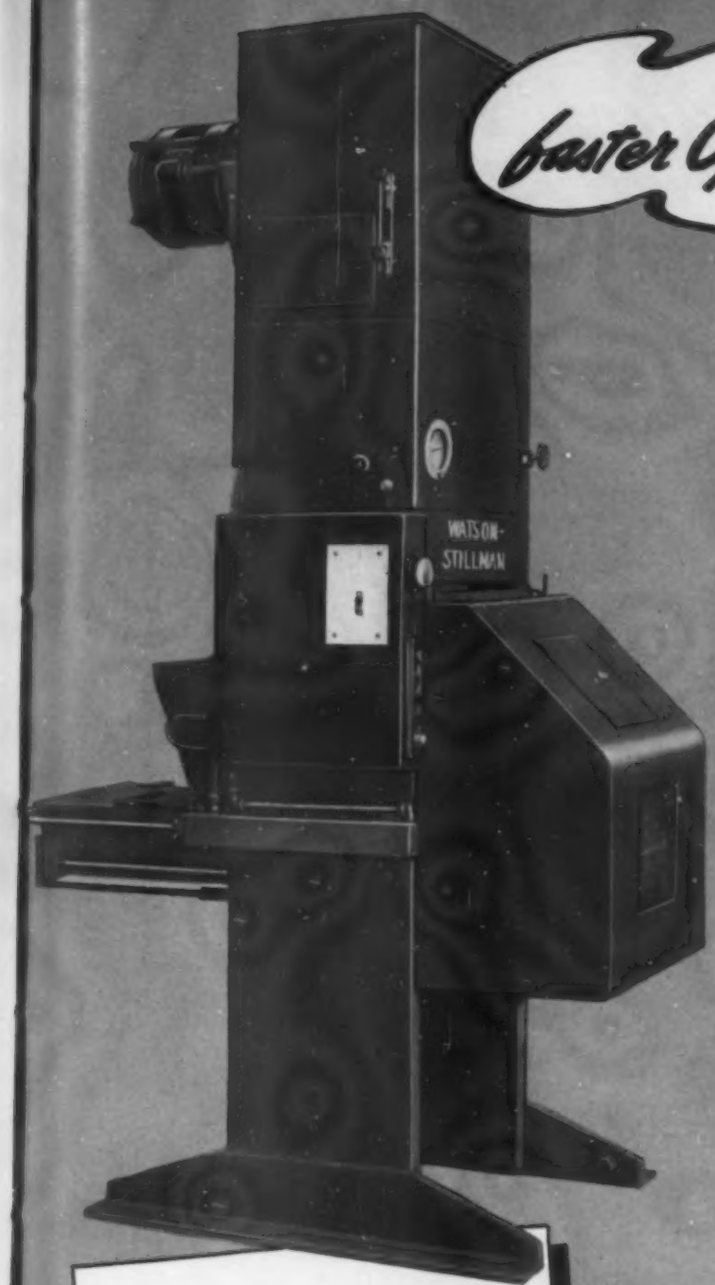

Newly improved, self-contained, 75-ton W-S fully automatic compression molding machine

SPECIFICATIONS

Capacity of hopper	40 lbs.
Die space	18" x 18"
Max. ht. each die half	8"
Stroke	10"
Vertical opening	22"
Max. hydraulic working pressure	900 lbs. per sq. in.
Approach speed	210 ins. per min.
Pressing speed	3.3 ins. per min.
Return speed	140 ins. per min.
Approx. weight	9000 lbs.
Floor space	3' x 6'
Height	10'4"
Motor	5 H.P.

AVAILABLE FROM 25 TO 100 TONS CAPACITY

This new W-S unit is fast! With a 10" stroke, advance is at the rate of 210" per minute, pressing speed 3.3" per minute, return 140" per minute. That means less waste time between curing periods. Higher tonnage enables the use of more cavities in the mold. Setting of pressures and timing can be made independently from a central control position, more easily and quickly than ever before.

Fully Automatic

Hydraulically operated feeder deposits a measured amount of material in each cavity. Machine closes with low pressure that is adjustable from 0 to 400 lbs., and can be degassed automatically if needed after low pressure period. High pressure is applied automatically and is also adjustable from 0 to 1000 lbs. The pieces are then stripped and blown into the automatic scale which weighs them. If the full shot is not discharged, the next cycle will not start and an alarm will ring.

Wide Use

These machines will mold any materials suitable for compression molding. Mold changes can be made rapidly, a big advantage on short runs. The machine has top and bottom ejectors.

Write for complete information about this new unit and W-S 25-ton and 50-ton machines.

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U. S. Plastics Patents

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CELLULOSE ESTERS. G. W. Seymour and Blanche B. White (to Celanese Corp. of America). U. S. 2,264,411, Dec. 2. Acylating cellulose with short chain aliphatic acid anhydrides in solution in the corresponding acid while preventing hydrolysis of the ester.

PROTEIN RESIN. H. M. Weber (to Prolamine Products Inc.). U. S. 2,264,732, Dec. 2. Making a water-soluble, alcohol-soluble thermosetting resin by reacting an alcohol-soluble protein with a phenolaldehyde condensation mixture.

TERPENE POLYMERS. W. E. Sheehan (to Neville Co.). U. S. 2,264,774, Dec. 2. Polymerizing a terpene in presence of aluminum chloride and separating the polymer from the catalyst.

HYDROCOLLOID MOLDINGS. W. J. Van Rossem (to Surgident Ltd.). U. S. 2,265,118, Dec. 2. Improving the molding properties of hydrocolloids such as agar by adding a slightly alkaline aqueous dispersion of an amphoteric hydroxide and a smaller amount of a borate.

PLASTICIZING POLYAMIDES. C. Coolidge (to E. I. du Pont de Nemours and Co.). U. S. 2,265,119, Dec. 2. Plasticizing a polyamide resin by selective absorption of a high-boiling carboxylic acid or a phenol or a sulfonamide plasticizer.

ETHYL CELLULOSE MELT. T. A. Kauppi and R. W. Kolderman (to Dow Chemical Co.). U. S. 2,265,173, Dec. 9. Compounding ethylcellulose with a tris(tert.-alkylaryl) phosphate or a diaryl ether derivative, and with a softer plasticizer, and handling the composition as a melt.

RESIN FROM WOOD. R. W. Martin (to Hercules Powder Co.). U. S. 2,265,181, Dec. 9. Heating wood with a rosin acid in water under pressure until the cellular structure disappears, and recovering a resin from the product.

CELLULOSE ESTERS. H. G. Stone (to Eastman Kodak Co.). U. S. 2,265,218, Dec. 9. Stabilizing cellulose acetate-propionate or acetate-butyrate by washing first with neutral water and then treating with slightly alkaline hot water to stabilize the ester.

CAST RESINS. J. H. Clewell and R. T. Fields (to E. I. du Pont de Nemours and Co.). U. S. 2,265,226, Dec. 9. Imparting integral sheen to cast organic polymer tubing by incorporating light-reflecting flakes in the resin.

MOLDING METHACRYLATES. S. S. Kistler (to E. I. du Pont de Nemours and Co.). U. S. 2,265,236, Dec. 9. Interpolymerizing methyl methacrylate with granular methacrylic acid polymer which is wet with monomeric methacrylic acid and heating the mixture.

METHACRYLATE RESIN. B. M. Marks (to E. I. du Pont de Nemours and Co.). U. S. 2,265,242, Dec. 9. Adsorbing acrylic or methacrylic acid on a granular methyl methacrylate polymer, washing with an alkaline sodium phosphate solution and washing the product until it is salt-free.

ACETAL AND KETAL RESINS. G. S. Stamatoff (to E. I. du Pont de Nemours and Co.). U. S. 2,265,255, Dec. 9. Condensing polyvinyl alcohol with butyraldehyde, valeraldehyde or a cyclic ketone in presence of methylolsufonic acid.

VINYL ALCOHOL PRODUCTS. W. O. Herrmann, E. Baum and W. Haehnal (to Chemische Forschungsges.). U. S. 2,265,283, Dec. 9. Extruding a hot aqueous polyvinyl alcohol solution through a nozzle and coagulating with hot air, in the manufacture of filaments or tubes.

ADDING PLASTICIZERS. W. H. Moss (to Celanese Corp. of America). U. S. 2,265,303, Dec. 9. Distributing a plasticizer over particles of a plasticizable substance which is wet with a nonsolvent, and evaporating the nonsolvent.

PLASTICIZED VINYL RESIN. F. Löblein (to Deutsche Celluloidfabrik Aktienges.). U. S. 2,265,436, Dec. 9. Plasticizing a vinyl resin on hot rolls and shaping the product in an extrusion press.

LACTAM POLYMERS. W. Reppe, Curt Schuster and A. Hartmann (to I. G. Farb. Aktienges.). U. S. 2,265,450, Dec. 9. Polymerizing N-vinyl lactams in aqueous sulfite solution.

CELLULOSE ESTER. R. Hofmann and W. Röhm (to I. G. Farb. Aktienges.). U. S. 2,265,528, Dec. 9. Acylating cellulose with an aliphatic acid in presence of sulfuric acid, but adding perchloric acid toward the end to improve clarity and transparency.

GLOSSY MOLDINGS. A. Kirkpatrick (to Monsanto Chemical Co.). U. S. 2,265,563, Dec. 9. Adding an aromatic acid or acid anhydride to a thermoplastic lignin resin to impart a gloss finish to laminated articles molded from the resin.

VINYL RESIN MOLDINGS. R. G. Aitken (to E. I. du Pont de Nemours and Co.). U. S. 2,265,619, Dec. 9. Compounding a vinyl acetate or vinyl acetal resin with a hydrogenated polymer of dihydronaphthalene to form a molding composition.

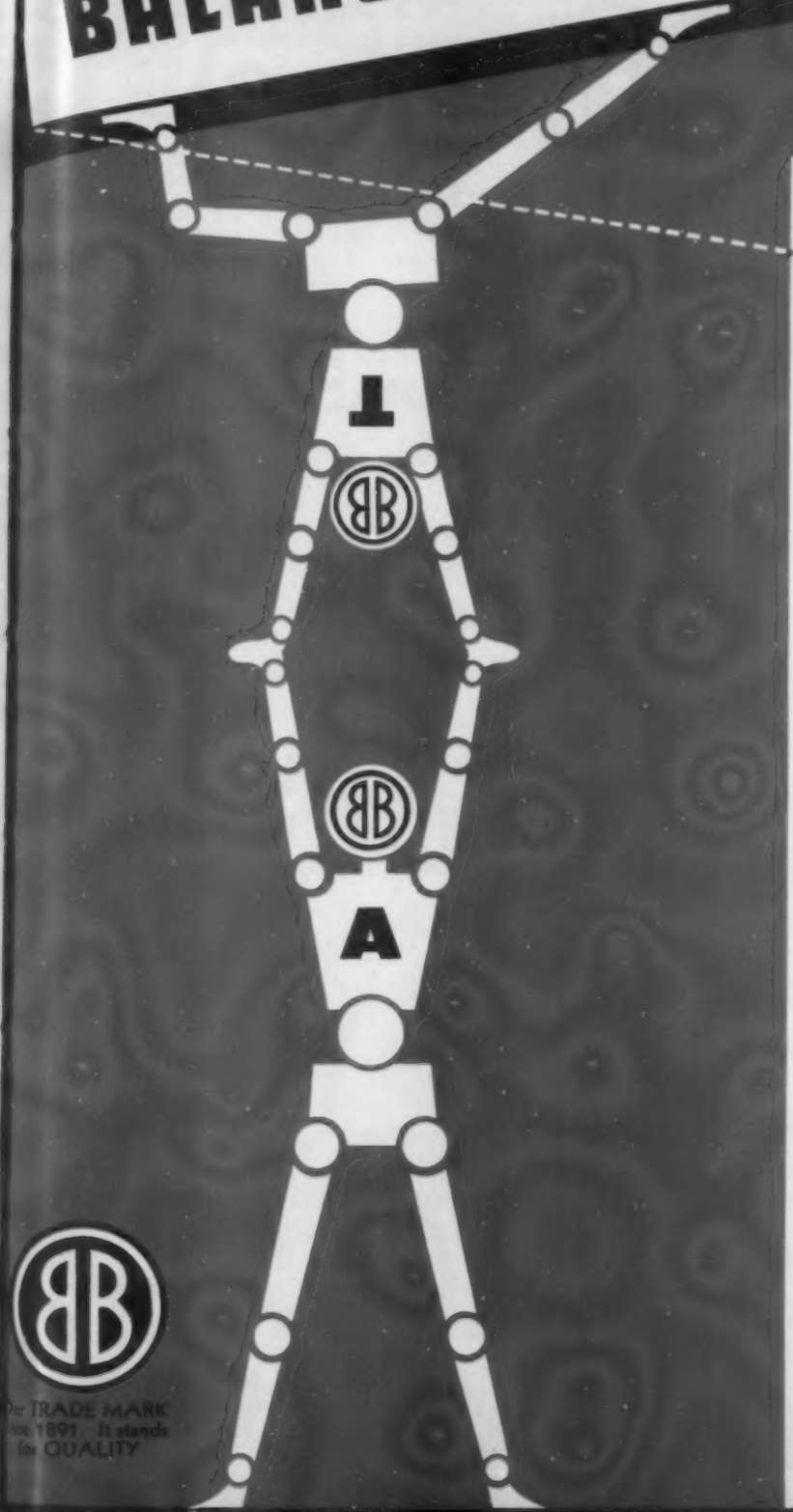
VINYL INTERPOLYMERS. B. S. Garvey and C. H. Alexander (to B. F. Goodrich Co.). U. S. 2,265,640, Dec. 9. Interpolymerizing a vinyl compound with an allyl ester or ether.

PHENOLIC RESIN. G. F. D'Alelio and J. B. Holmes (to General Electric Co.). U. S. 2,265,688, Dec. 9. Condensing a phenol with an aldehyde and a smaller proportion of a benzoylsulfimide.

PETROLEUM RESIN. K. C. Laughlin and S. D. Sumerford (to Standard Oil Development Co.). U. S. 2,265,847, Dec. 9. Condensing petroleum aromatics with an alkyl dihalide in presence of aluminum chloride.

CELLULOSE ETHERS. L. Lilienfeld (to Lilienfeld Patents, Inc.). U. S. 2,265,913-4-5-6-7-8-9, Dec. 9. Making alkanol-alkyl ethers of cellulose, xanthating a water-insoluble, alkali-

BALANCED PRODUCTION



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soluble cellulose ether, forming shaped products from a xanthated cellulose ether, regenerating xanthated cellulose ethers, making ethylcellulose, making mixed (alkanolalkyl) cellulose ethers and heating a cellulose ether in an inert atmosphere to improve its alkali solubility and viscosity.

TASTELESS ODORLESS PLASTIC. H. R. Dittmar (to E. I. du Pont de Nemours and Co.). U. S. 2,265,937, Dec. 9. Removing taste and odor from butyl methacrylate polymer by heating the powdered polymer with aqueous alkali containing a small amount of methylated starch.

DIE CASTING. P. Beyerlein (to Eckert und Ziegler G. m. b. H.). U. S. 2,265,995, Dec. 16. A closure for the nozzle of a die-casting cylinder head includes a spring-controlled plug and a hollow nozzle head having transverse passages leading to the nozzle passage.

MOLDING MACHINE. J. B. Tegarty (to Sterling Injection Molding, Inc.). U. S. 2,266,129, Dec. 16. In a machine for molding thermoplastics one die plate is forced toward the other by a power-operated mechanism which is opposed by parts connected by straight tie bars and an arched tie member.

UREA RESINS. A. Rieche, W. Rudolph and R. Klar (to I. G. Farb. Akt.). U. S. 2,266,265, Dec. 16. Condensing urea, thiourea, urethane, biuret, guanidine, melamine or cyanuric acid derivatives and lignin sulfonic acids or their salts with formaldehyde or furfural to form a resin.

CUBE TRAY LACQUER. Clifford R. Carney. U. S. 2,266,353, Dec. 16. Coating ice cube trays and grids with a baked enamel containing glycerol phthalate and a urea-formaldehyde resin.

SYNTHETIC FIBERS. G. D. Graves (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,226,363, Dec. 16. Extruding filaments from a melt of an organic fiber-forming polymer.

SYNTHETIC FIBERS. D. R. Hull, W. W. Heckert and J. Alfthan (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,266,368, Dec. 16. Extruding filaments from an organic polymer melt through a spinneret pack of inert particles.

PAPER DRILL. H. J. Hoffman (to Smead Mfg. Co.). U. S. 2,266,393, Dec. 16. A plastic handle for a paper drill has a chamber in which the bit may be carried when not in use.

FILM. G. F. Nadeau and C. B. Starck (to Eastman Kodak Co.) U. S. 2,266,435, Dec. 16. A paper-backed photographic stripping film has the temporary paper backing faced with a cellulose ester and a layer, incompatible therewith, of cellulose ester, resin or wax between the temporary backing and the cellulose ester permanent support.

ROSIN DERIVATIVE. Israel Rosenblum. U. S. 2,266,568, Dec. 16. Modifying rosin with a phenol-ketone resin for use in nonpenetrating varnishes.

HEEL. A. C. Treece (to General Electric Co.). U. S. 2,266,575, Dec. 16. A guide for inserting heel pins in shoe heels is made of a perforated hardened plastic material.

INDENE RESIN. W. H. Carmody (to Neville Co.). U. S. 2,266,675, Dec. 16. Minimizing the after-yellowing of indene resins by catalytic hydrogenation of the resin.

CASEIN GLUE. Lawrence Bradshaw. U. S. 2,266,736, Dec. 23. A dry base for mixing with water to make casein glue is composed of milk casein, lime, an alkaline solubilizing agent and a zinc salt to accelerate setting.

RUBBERY POLYMERS. W. Pannwitz, B. Ritzenthaler, H. Hopff and G. Steinbrunn (to I. G. Farb. Akt.). U. S. 2,266,794, Dec. 23. Making rubber-like products by emulsion inter polymerization of a diolefin with a fumarate ester.

CONDENSER DIELECTRICS. Samuel Ruben. U. S. 2,266,809-10-1-2-3-4, Dec. 23. Composite dielectrics for electrostatic condensers contain a thermoplastic, thermo-adhesive fusible hydrogenated polymeric hydrocarbon resin and a plasticizer, e.g., hydrogenated rosin and castor oil or polychloronaphthalene; or hydrogenated polystyrene; or hydrogenated castor oil and polychloronaphthalene; or a resin dissolved in a mixture of ethyltetrachloro- and ethylpentachlorobenzene.

INJECTION MOLDING. J. B. Tegarty (to Standard Products Co.). U. S. 2,266,831, Dec. 23. An injection mold is formed of several parts, made of gas-tight material and joined to form a smooth mold wall, the seams of which permit escape of gas at high pressure, but retain the molding composition.

LAMINATED CLOTH. W. S. Taylor (to Hercules Powder Co.). U. S. 2,266,940, Dec. 23. Laundry-fast collars, cuffs and shirt fronts are made of cloth plies joined by a thermoplastic nonbleeding bonding material containing ethylcellulose and a water-insoluble wax.

HYDROLYZED VINYL POLYMERS. N. D. Scott and J. E. Bristol (to E. I. du Pont de Nemours and Co., Inc.) U. S. 2,266,996, Dec. 23. Partially hydrolyzing polyvinyl acetate with a hydrolytic alcohol in an anhydrous medium in presence of an alkaline catalyst.

SHOE. Jos. K. Molnar. U. S. 2,267,125, Dec. 23. A shoe having a plastic counter (including an insole which is perforated for ventilation) and a plastic hollow heel into which some of the insole perforations open.

EMBEDDING MEDIUM. P. Gray (to Stoner-Mudge, Inc.). U. S. 2,267,151, Dec. 23. Embedding specimens for microscopy in paraffin wax compounded with a hydrogenated polymer of cyclopentadiene, coumarone, indene or the like and a flexibilizing agent which may be rubber or a polymer of butadiene, chloroprene, isobutene, isoprene, divinylacetylene or the like.

RELAY. C. P. Clare and G. Weinrich (to C. P. Clare and Co.). U. S. 2,267,191, Dec. 23. A spacer for relay springs is made with a shell of phenolic resin impregnated paper coiled around a rod of similar paper with planar cleavage lines.

SHRINK CAP. F. H. Reichel (to Sylvania Industrial Corp.). U. S. 2,267,217, Dec. 23. Shrink cap tubing is formed from a blend of cellulose xanthate (from which cellulose is regenerated after extruding the tube) and an alkali-soluble cellulose ether.

TEXTILE FINISH. O. B. Hager (to Röhm and Haas Co.). U. S. 2,267,276, Dec. 23. Textiles containing a urea-formaldehyde finishing resin are treated with a peroxide to prevent development of odors.

SOAP PACKAGE. W. V. Shearer and G. Householder (to Plastic Coating Corp.). U. S. 2,267,310, Dec. 23. Sealing bar soap in a moistureproof, acidproof, alkaliproof sheath of vinyl resin.

PRESSED FIBER. W. R. Thompson and W. E. Flood (to Catalin Corp. of America). U. S. 2,267,316, Dec. 23. Impregnating fiber with a phenolic resin made with the aid of a phosphoric acid catalyst, setting the resin in the fiber while retaining its water, and hardening the resin to form a porous product.

LAMINATED PRODUCTS. G. Alexander (to General Electric Co.). U. S. 2,267,390, Dec. 23. A thermosetting cresol-xylenol-formaldehyde resin for use in a punch stock varnish.

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Plastics digest

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to individual publishers

General

TROOP-CARRYING GLIDER. Aero Digest *40*, 299 (Jan. 1942). Included in recent Navy Department contracts was one for 12-place troop-carrying gliders of plastic-bonded plywood construction, awarded to the Allied Aviation Corp. In the construction of these gliders, the Navy Department has been most emphatic that they shall be built, in so far as possible, from non-strategic materials. Molded plastic plywood was the accepted choice. The molds are constructed of wood. A plastic is suitable for use in the fabrication of stressed and loaded structures only when a filler, such as cloth or wood, is used. The resin serves as a bonding agent supporting fibers of complex structures and transmitting a load from one to the other. Because of favorable strength weight ratio, wood veneers are especially suitable for use as the reinforcing element in aircraft structures molded under fluid pressure. The resin provides a bond between the plies which is not only waterproof and fungus-proof but is also stronger than the original wood itself in shear.

DEVELOPMENT OF NYLON. E. K. Bolton. Ind. Eng. Chem. *34*, 53–8 (Jan. 1942). In an address delivered by the author on the occasion of the award of the Chemical Industry medal of the Society of Chemical Industry, the fundamental research and plant engineering developments which resulted in the production of nylon yarn and nylon hosiery were reviewed. On February 28, 1935, the superpolymer from hexamethylenediamine and adipic acid was first synthesized. The Seaford plant early in 1940 started the commercial production of yarn made from polyhexamethylene adipamide. Nylon yarn is currently being made at the rate of 8,000,000 pounds per year with additional capacity under construction to double this output in the summer of 1942.

ARALAC—A NEWCOMER IN THE GALAXY OF TEXTILE FIBERS. F. C. Atwood. Chemical Industries *49*, 822–4, 828 (Dec. 1941). The National Dairy Products Corp. initiated an investigation of the production of a textile fiber from milk casein late in 1937. A commercial plant was placed in operation in the summer of 1940. Present production capacity is about 5,000,000 pounds of fiber per year. It is used in the manufacture of felt hats and for blending with other fibers used in the textile industry. It is estimated that there is sufficient skim milk available annually to furnish over a billion pounds of casein.

Materials

COAL BY-PRODUCTS. SOLUBILIZING EFFECT OF HYDROGENATION UPON AROMATIC-DERIVED RESINS. W. H. Carmody. Ind. Eng. Chem. *34*, 74–8 (Jan. 1942). Recent examination of indene-coumarone polymers revealed that the entry of hydrogen into the molecule takes place in three definite zones. Complete saturation destroys all tendency of the polymers to associate in solution. The polymers are rendered almost chemically inactive and they become easily soluble in petroleum cuts over a wide range. Selectively hydrogenated indene-coumarone resins will eventually displace the earlier haphazard type of hydrogenated products, mainly on the basis of greater economy and performance superiority.

PLASTICIZERS. F. J. Van Antwerpen. Ind. Eng. Chem. *34*, 68–73 (Jan. 1942). The properties of plasticizing compounds manufactured in America and commercially available are tabulated.

Applications

DRAWN RIGID PLASTIC CONTAINERS AND DISPLAYS. Modern Packaging *15*, 83–4, 86 (Jan. 1942).

ETHYLCELLULOSE SHEETING IN PACKAGE FABRICATION. F. C. Dulmage, Jr., and T. A. Kauppi. Modern Packaging *15*, 88, 90, 92 (Jan. 1942). Latest progress in the field of drawing, swedging and molding thermoplastic package containers and displays is reviewed in this and the preceding reference. Examples of other products, such as ice cube trays, flower pots and fluorescent-lighting fixtures, are cited to show the inherent possibilities of these materials and processes.

PLASTIC INSULATED SLEEVINGS. A. Cornehli. Plastics *5*, 236–7 (Dec. 1941). Plastic sleevings for electrical conductors have replaced to a large extent the oil-varnished braided fabric for telephone and radio apparatus, relays, meters, time switches and various other instruments. Polyvinyl chloride and cellulose acetate sleevings comply with the specifications of the Post Office, Admiralty, Air Ministry and other Government Departments in Great Britain.

RESINOUS CONDENSATION PRODUCTS FOR PROTECTIVE AND DECORATIVE COATINGS. T. S. Hodgins and A. C. Hovey. Chemical Industries *49*, 448–52 (Oct. 1941). A review of the development of synthetic resins for use as protective films over industrial and household equipment.

Properties and Testing

ACCELERATED TESTING OF PLASTICS FOR WEATHERING RESISTANCE. L. K. Merrill and C. S. Myers. A.S.T.M. Bulletin No. 113, 19–23 (Dec. 1941). Use of the National Accelerated Weathering Unit permitted the prediction with considerable accuracy of the results to be obtained when plastics are exposed to normal outdoor weathering. This apparatus provides a close approximation to characteristics of true solar energy and control of temperature, humidity and contact moisture.

LIGHT AND ACCELERATED LIGHT AGING OF RUBBER, SYNTHETIC RUBBER, AND RUBBER SUBSTITUTES. T. A. Werkenthin, D. Richardson, R. F. Thornley and R. E. Morris. Rubber Age *50*, 103–8 (Nov. 1941); 199-202 (Dec. 1941). Results of exposure and accelerated aging tests on natural and synthetic rubbers are reported. Tensile strength and elongation measurements were found to be better criteria of breakdown than checking or cracking of the surface. Neoprene proved to be particularly resistant to aging in these tests.

TEMPERATURE DEPENDENCE OF YOUNG'S MODULUS AND INTERNAL FRICTION OF LUCITE AND KAROLITH. J. S. Rinehart. J. App. Physics *12*, 811–16 (Nov. 1941). Curves of the reciprocal of Young's modulus versus temperature showed positive curvatures for both materials at the higher temperatures. Lucite (methyl methacrylate) was investigated from −55 deg. to 65 deg. C. and Karolith (casein plastic) from 25 deg. to 110 deg. C. At room temperature the Young's moduli of Lucite and Karolith were 4.72 and 6.14 dynes/cm.^{2}, respectively. Absorbed water has a pronounced effect upon the Young's modulus of Karolith. The specific energy loss was found to vary with frequency for both materials and varied in a linear fashion for Lucite at room temperature.

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High Polymeric Reactions. Their Theory and Practice.

by H. Mark and R. Raff
Interscience Publishers, Inc., 215 4th Ave., N. Y., 1941
Price, $6.50. 476 pages

This is Volume III in a series of monographs on the chemistry, physics and technology of high polymeric substances. Volumes I and II were reviewed in the January and May 1941 issues, respectively, of MODERN PLASTICS. In this latest contribution the authors have dealt with the elementary molecular processes involved in such steps as activation, propagation, chain-branching, termination and ring-closure. They have collected and presented the most significant and recent information on the quantitative aspects of orders of reaction, activation energies and steric factors in polyreactions.

Part 1 pertains to the important general relationships involved in the mathematical derivation of certain guiding principles in high polymeric reactions. This portion of the book includes a discussion of the structure of high polymers, some data on experimental methods of preparation and characterization, the fundamentals of reaction kinetics and the general theory of the mechanism of polyreactions. Part 2 treats of special polymerizations and polycondensations, arranging the material according to the classification which is common in organic chemistry. This provides a broad picture of what has been done with many individual polymerizable compounds, particularly those investigations in which kinetic methods were applied. The subdivision of this special part according to specific chemical compounds and 40 pages of author and subject indexes make this book an outstanding ready reference for information on the quantitative aspects of polymerization. G.M.K.

Handbook of Chemistry and Physics—25th Edition

Charles D. Hodgman, Editor-in-Chief
Chemical Rubber Publishing Co., Cleveland, Ohio, 1941
Price $3.50 2503 pages

The 1941–42 edition of this well-known source of chemical and physical data contains some new or completely revised tables as well as minor revisions of the text throughout to bring the information up to date. It includes such data as Physical Constants of Inorganic, Organic, and Industrial Organic Compounds, Mathematical Tables, Specific Gravity and Other Properties of Matter, Conversion Tables for Quantities and Units, Definitions and Physical Data Pertaining to Heat, Light, Sound, Electricity and Magnetism, Properties of Commercial Plastics, and General Chemical Tables. A detailed index facilitates location of specific items in this comprehensive reference book. G. M. K.

★ MELMAC 494, THE NEW MELAMINE-MINERAL-filled molding compound developed by American Cyanamid Co.'s Plastics Div., 30 Rockefeller Plaza, New York City, is briefly described in a 4-page folder, which contains a page of technical data and some suggested applications, including terminal blocks, circuit breakers, magneto parts, distributor heads and ignition systems. This thermosetting material is said to have unusually high arc resistance and dielectric strength at normal and elevated temperatures, and to retain these qualities under varying conditions of climate and humidity.

★ THE SYNTHETICS DEPARTMENT OF HERCULES Powder Co., Wilmington, Del., has put out a booklet on Flexalyn, their balsamic ester of abietic acid, which gives its properties and discusses suggested applications. Briefly, Flexalyn is described as a neutral, persistently adhesive resin with a high refractive index which is alkali- and water-resistant, compatible with most film-formers and miscible with the hydrophyllic colloids. The company offers it as a plasticizer, tackifier or toughener—in adhesives (paste, glue, hot-melt pick-up adhesives), protective coatings (paints, wallboard coatings, varnishes, lacquers) and in the formulation of many types of plastic compositions.

★ A NEW CATALOG DEVOTED TO ITS RESINOX MOLDing materials has been distributed by the Monsanto Chemical Co., Springfield, Mass., accompanied by a statement emphasizing their current use in actual military equipment as well as in parts, appliances and machinery contributing to the war effort. The catalog, illustrated in color, describes the manufacture of Resinox molding powder, the molding operation and the uses of the molded parts

★ THE PLASTICS DIV. OF ERIE RESISTOR CORP., Erie, Pa., has issued an illustrated pamphlet describing their injection molded and extruded plastic parts. A properties chart is included.

★ IN RESPONSE TO A REQUEST FOR A SIMPLIFIED, non-technical description of the new Bakelite C-9 resins, the Bakelite Corp., Bloomfield, N. J., has issued a brief booklet setting down their properties and listing ways in which they may be applied. The designation C-9 is used to identify the entire new group of resins based on carbic anhydride, a development of Carbide and Carbon Chemicals Corp., which is subdivided into Type I (liquid, oil-reactive) and Type II (solid, resin-modified).

★ "STRENGTH PLUS FLEXIBILITY" IS THE FORMULA chosen by American Metal Hose, Branch of American Brass Co., Waterbury, Conn., to describe their product in a folder which lists and illustrates some widely varying applications of metal hose. Among those chosen: a clothing press; automobile tire molding machine; a dictaphone; distillery scale tanks; metabolism testing apparatus.

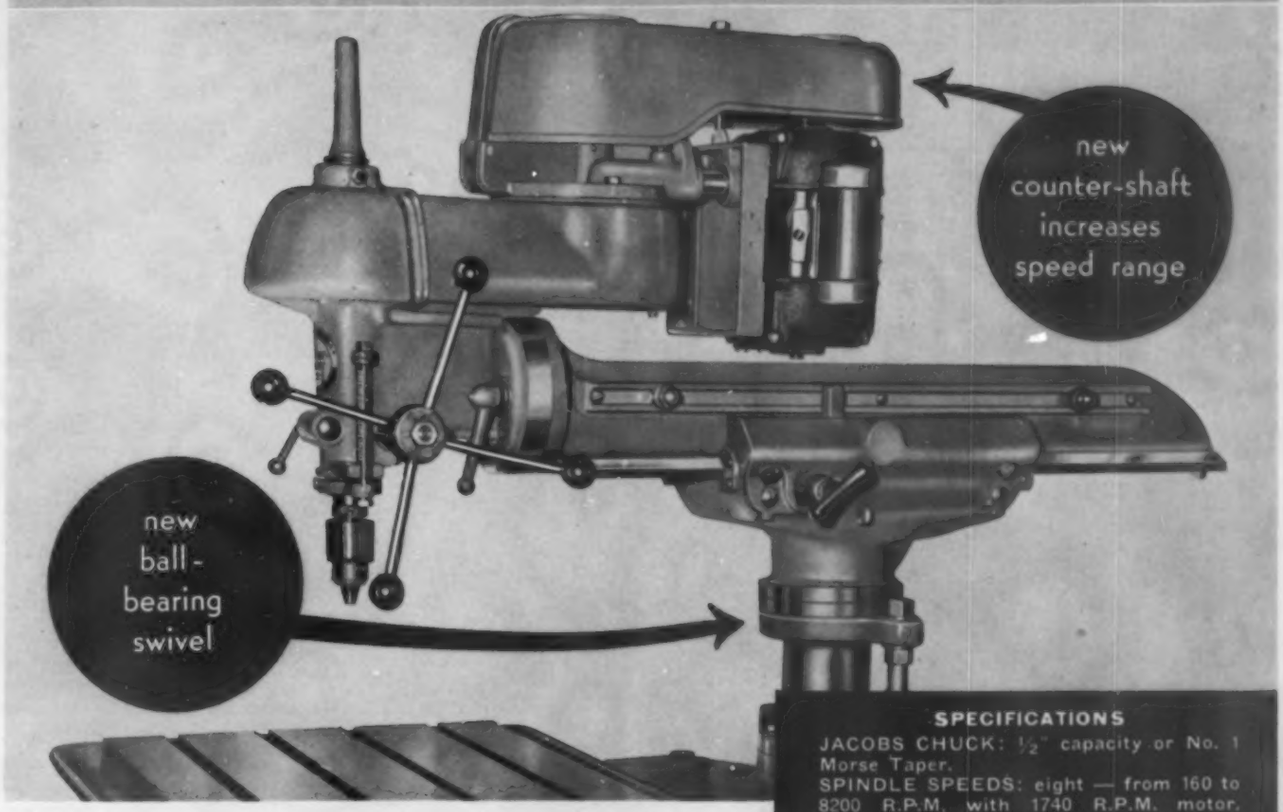
★ BULLETIN NO. 121 PUT OUT BY THE B. M. ROOT CO., York, Pa., illustrates and describes the company's various types of electro-hydraulic boring machinery, suitable for boring holes in wood, plastics and composition materials.

★ A WEEKLY BULLETIN, *OPM CONTRACT NEWS*, is issued each Thursday by the New York Division of Contract Distribution, OPM, for the purpose of bringing small manufacturers into war production through prime contractors. The bulletin, which lists types of facilities sought by prime contractors who have war work to lease on a sub-contract basis, is distributed free of charge by the Division's headquarters at 122 East 42nd St., New York City.

★ A CONDENSED CATALOG WHICH MAY BE FILED for ready reference is Bulletin 67-T, describing the No. 2-H turret lathe of the South Bend (Indiana) Lathe Works. The new lathe is adaptable to either long-run or small-lot production on a wide range of bar, chucking or fixture jobs.

★ A NEW 4-PAGE BULLETIN, *HAND PUMPS*, ISSUED by the Watson-Stillman Co., Roselle, N. J., describes hand operated, high pressure pumps for testing purposes and for operating hydraulic jacks and other small hydraulic tools. Pressure capacities of the pumps shown range from 1500 to 30,000 lbs. per sq. in. Ten different types of pumps are illustrated, including single and double plunger types, the latter for use where high speed of initial movement is required.

This *new* WALKER-TURNER RADIAL DRILL handles a wider range of work



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Last year Walker-Turner made available to industry the first low-cost Radial Drill for light duty operations such as drilling, tapping, routing and light profiling. Defense plants particularly have been able with these new machines to speed up work at many points where it has been lagging, in aircraft plants, ship yards, ordnance plants, etc. Repeat orders by the hundreds prove that it is finding its place in industry. As its use became more widespread, we have found that the drilling requirements of some concerns are so varied as to warrant an increase in the speed range. We, therefore, offer our new Counter-Shaft Model, which has a speed range from 160 to 8300 R. P. M. Another model is available with ball-bearing mounting for the sliding mechanism and heads to enable the operator to swing the head in a horizontal arc with finger-touch ease. This company will also continue to manufacture the original model. Send coupon today for full particulars.

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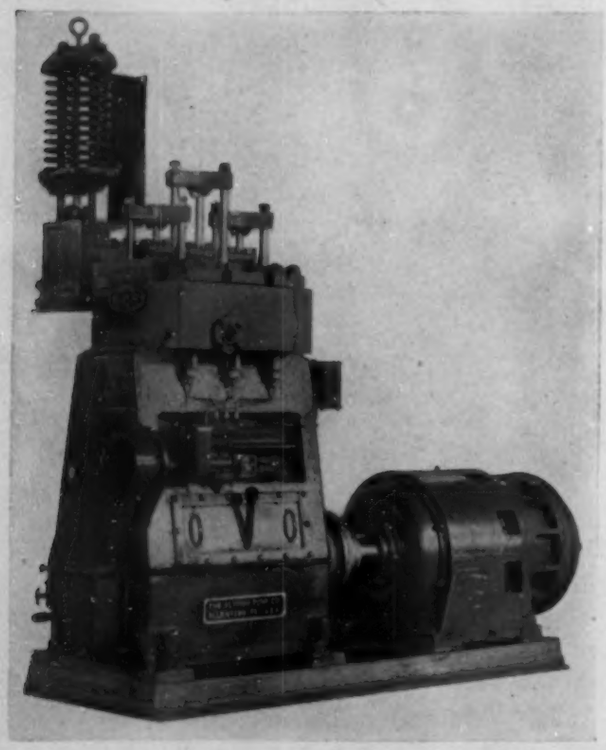
Machinery and Equipment

★ A PORTABLE COOLANT PUMP WHICH THE MANUfacturer terms, "particularly efficient for buffing operations," has just been announced by Gray-Mills Co., Inc. Particular advantages of the pump are its portability, the ease of regulation of coolant flow—from a drop to a full stream—the ability of the pump to withstand continuous operation, the ease of replacement of all wearing parts, and the low price of the unit.

★ A NEW HOT STAMPING MACHINE FOR MARKING graduated sleeves for binoculars after enameling is announced by Acromark Corp. According to the report, the machine marks sleeves of plastic, aluminum, copper, etc., by applying the white or silver filling with heat all in one operation.



★ A NEW LINE OF HIGH PRESSURE VERTICAL TRIplex constant stroke pumps (above) have been developed by the Aldrich Pump Co. Pumps are of various sizes from 10 to 150 hp. for pressures up to 9800 p. s. i. and capacities up to 220 g. p. m. Improved design of these pumps is said to make them applicable to gear-head motor or speed reducer drive. They can be fitted with suction valve controls, as shown, for use with hydraulic accumulator systems where server presses are in work.

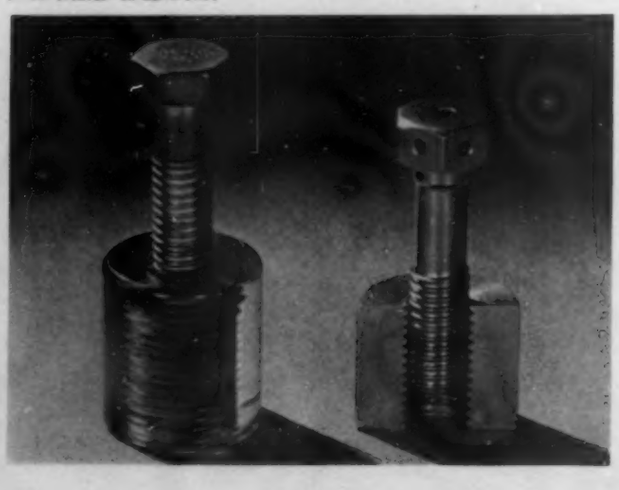
★ DESCRIBED AS SIMPLE, COMPACT AND INEXpensive the Doall Rectifier, just released by the Savage Tool Co., will be of special interest to those plants where alternating current must be transformed into direct current for the operation of electromagnetic chucks. There are no moving parts to wear out or servicing costs, as is common in motor generator plants. It is packed in a self-contained 11 in. by 4¾ in. by 7¾ in. welded steel case, operated from a toggle switch. The unit is fused to prevent damage to either Rectifier or magnetic chuck.

★ PACKLESS METAL PRODUCTS CORP. have recently developed and marketed a new design in flex-control for use on hydraulic platen presses. This improved unit (above), easily applied on the press, is said to eliminate hose strain and speed production by avoiding replacement of piping and servicing of swing and sliding joints. These flex-control assemblies are supplied in seven different inside diameters, from ¼ in. to 1½ in., and are adapted for presses used in plastics manufacture.

★ A SMALL ABRASIVE BELT SANDER-GRINDER (type G-4) which utilizes a belt 4 in. wide by 45 in. in circumference has been added to the Porter-Cable Machine Co. line of precision machinery. It is equipped for dry belts or resin-bonded abrasive belts on which water, or other coolant, is sprayed. The manufacturer recommends the machine for sanding or grinding small parts of plastic, fiber hard rubber, etc. It is said to be capable of handling light milling and grinding operations without the use of fixtures.

★ AIRCRAFT SCREW PRODUCTS CO. HAS DEVELOPED a new type of screw fastening for plastics which, though originally intended for aircraft construction, can be adapted to many other types of equipment. A hard spring wire thread insert is first screwed in the tapped hole. The insert is so designed that when it is in place, it expands against the threaded grooves to form a hard metal thread lining which cannot be removed nor displaced by the engaging screw member. The smooth, polished thread surface permits the use of a shallow round-bottom thread groove on the mating screw, which results in greatly increased strength. Screws can be removed and reassembled any number of times without wearing out the tapped hole. (See cut below.)

PHOTO. COURTESY BAKELITE CORP.



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The steel block, shown above, with its variety of geometric forms, was milled completely on both sides, without models or templates, in one setup on the Milwaukee Model D Rotary Head Tool and Die Milling Machine. At no time during the entire milling process was either block moved from its original position in the milling machine vise. This is another example of speed and versatility of a Milwaukee Model D — the machine that transmits blueprint into steel in a single setup — layout, milling, drilling, precision boring and slotting operations.

Investigate this machine and the new technique it offers for the production of dies and tools — in far less time, with positive accuracy, and at very low cost.

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Milwaukee MODEL D ROTARY HEAD TOOL AND DIE MILLING MACHINE

Milwaukee MILLING MACHINES

In the plastics picture

★ THE TECHNICAL COMMITTEE OF THE SOCIETY of the Plastics Industry met with representatives of various Government Departments and aircraft firms on Jan. 14 in Dayton, Ohio, to discuss "Plastics Applications in Military Aircraft." A special bulletin of the Society indicates that the conference brought many current problems to the plastics industry's attention as well as many potential applications. Aircraft representatives in particular stated that one of their biggest problems in applying plastics was their inability to obtain reliable engineering data pertaining to these materials.

F. B. Fuller, W. R. Koch and Lt. W. A. Seiler presented problems in plastics confronting the U. S. Army Air Corps. Their experiences with structural and non-structural plastic parts were reviewed and various prospective applications of plastics in photographic and engine parts were discussed. Reference was made to the testing procedures and minimum requirements for structural plastics published in J. B. Johnson's paper on "Structural Plastics in Aviation" in the November 1941 issue of MODERN PLASTICS. Information regarding current Air Corps specifications is reported in Bulletin 23, available from the Technical Data Section, U. S. Army Air Corps, Wright Field, Dayton, Ohio. H. Sang of the Naval aircraft factory stated that information was particularly needed concerning the following properties of plastics: Basic mechanical strengths, fatigue, creep at elevated temperatures, weathering and effects of arctic and tropical climates. Progress was reported in the evaluation of plastics and their application in aircraft parts.

The general opinion of aircraft manufacturers' representatives who addressed the conference was that more complete technical information on all types of plastics is needed. George deBell, Glenn L. Martin Co., described the procedure followed by that company in experimental development of plastic parts: namely, a thorough discussion of the problem with a representative group from the industry, followed by the selection of a particular firm for following through on the item. He urged molders to prepare to handle complete assemblies and emphasized the importance of deliveries on schedule. S. K. Hodgson, Vought-Sikorsky Aircraft, Div. of United Aircraft Corp., described plastics applications in airplanes which his firm has developed since 1934. He spoke particularly of difficulties encountered in attachment of plastics to metals. W. D. Craig, Jr., Grumman Aircraft Engineering Corp., cited the aluminum industry as an example of one which had undertaken exhaustive work to encourage the use of the metal in aircraft. The abundance of engineering data available on aluminum facilitated and accelerated its extensive use.

Dr. G. M. Kline, National Bureau of Standards, emphasized that the situation of the plastics industry with respect to the aircraft industry was complicated by several factors which tended to impede progress. The aircraft industry has priority on the use of the available light alloys and hence feels that the burden of the proof for their replacement by plastics rests with the plastics industry. The plastics industry, on the other hand, does not have the prospect of sufficiently large volume business in aircraft parts to make extensive development work economically feasible. The primary incentive in this case is to put plastics to work wherever possible in the Victory program. The producer of aluminum could undertake expensive research and development work with the realization that the cost of same could be charged to whatever alloy was finally selected for the job. The individual plastics manufacturer or molder, however, cannot afford to put in a similar effort on an aircraft material or part because even if the search for a suitable product is successful, he is unable in the face of competitive bidding to be assured either of a profitable item of business or of an opportunity to recover the expenditures involved in the development work. Thus, progress in the applications of plastics in aircraft calls for concerted action by the whole industry as well as by individual effort if possible.

In particular, Dr. Kline stressed that a material suitable for the construction of inexpensive experimental molds is needed to enable actual parts to be made available for service tests without prohibitive costs. He also proposed that the plastics industry consider the elimination of much of the secrecy now existing regarding the composition of commercial plastics. If plastics are to become recognized structural materials, information of the type available in handbooks regarding metal alloys will have to be disseminated. Plastic compositions are similar to alloys in that their behavior in service is to a large extent dependent upon modifying elements or compounds added to the basic material. If an alloy fails, it can be attributed to the presence or absence of some minor constituent according to information revealed in the composition columns in the handbook; but if a plastic fails, in the absence of specific composition data, that particular type of plastic is apt to be rejected from further consideration. If the hocus-pocus involved in mystic numbers, letters and names could be discarded by the plastics industry and an intelligent consideration of facts correlating service behavior with composition could be substituted, industrial accomplishments in plastics should progress more rapidly and more satisfactorily, both in aircraft and in fields involving much larger tonnages of materials. Dr. Kline also reviewed the work which Committee D-20 of the American Society for Testing Materials is doing in the development of testing methods for plastics and indicated that material contributions to our knowledge of the basic mechanical properties of plastics are resulting from its investigations. However, this must necessarily be supplemented by studies of the behavior of structural parts under load to obtain the engineering data required for proper design of molded parts.

Representatives of materials manufacturers and molders commented upon the speakers' remarks and contributed to the discussion as the meeting progressed. The Technical Committee met following the open sessions to review the proceedings and suggestions. Further meetings of the Technical Committee have been announced by the Society and plans are being formulated for further conferences with other Government agencies to expedite the utilization of plastics in the Victory program to the fullest possible extent wherever they can do the job best.

★ AT THE JANUARY 8, 1942 ANNUAL MEETING OF THE Plastics Materials Manufacturers' Association, the following officers were re-elected: Arnold E. Pitcher, General Manager of the Plastics Department of E. I. du Pont de Nemours & Co., Inc., President; L. M. Rossi, Vice-President of the Bakelite Corp., Vice-President; John E. Walker, Washington, D. C., Secretary and Treasurer. This association was organized on April 24, 1941.

The primary activity of the association during the period of the war will be continued cooperation with the various governmental agencies in providing plastics for defense and civilian uses to the extent that raw materials are available.

★ WITHIN THE PLASTICS INDUSTRY, THE FIRST instance of pooling of manufacturing resources to secure war contracts that has come to our attention is at Leominster, Mass. Slightly more than 50 percent of the city's industrial life consists of the manufacture of small plastic articles, chiefly of the cellulosic variety. Realizing that many of these now come under the heading of non-essentials, and that raw materials needed for their manufacture are being diverted to war industries, the Chamber of Commerce called a meeting of all the plastics manufacturers in the community to consider the situation and to take steps to alleviate it.

It was decided to set up within the Chamber of Commerce a Plastics Manufacturers Group in accordance with one of the plans approved by the OPM for facilitating the wider participation of small business in armament production. A statistical and an engineering committee were appointed, in addition to the committee which will represent the Leominster group. The sta-

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Many of these machines are already at work on such jobs as trimming and routing of plexiglass for gun blisters and windshields. Also used in the construction of mine sweepers.

FOR CARVING and INLAYING on LIGHTER WORK . . . . . such as the manufacture of plastic jewelry and ornaments, many users have selected the

CARTER RS4 ROUTER with Carving Spindle and Base ⅓ H.P. 18,000 R.P.M.

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WANTED: Injection Molding Acetate Scrap or Rejects in any form, including Styrene, Acrylic, Butyrate, Vinyl Resin Scrap materials. Submit samples and details of quantities, grades and colors for our quotation. Reply Box 508, Modern Plastics.

FOR SALE: Stokes Rotary Tablet Machine, Type DD, 500 to 700 Tablets per minute, 5/16" to 1 1/16" Tablets. 15 x 15" Watson-Stillman Transforming Press with Pushbacks and Ejectors. Reply Box 512, Modern Plastics.

FOR SALE: 400 ton horiz. Hydraulic extrusion press. Hydraulic scrap baler, 80 ton, 6½" ram, 90" stroke, 5000 lbs. per sq. in. W. & P. mixer, size 15. 75 ft. link belt conveyor, 36" wide. Large stocks of Hydraulic presses, pumps & accumulators, preform machines, rotary cutters, mixers, grinders, pulverizers, tumbling barrels, gas boilers, etc. Send for Bulletins #156 and #138, and L-17. We also buy your surplus machinery for cash. Reply Box 439, Modern Plastics.

WANTED: Stainless Steel or Nickel Kettle, Vacuum Pan, Hydraulic Press, Preform Machine and Mixer. Reply Box 275, Modern Plastics. No dealers.

FOR SALE: 16—SEMI-AUTOMATIC HYDRAULIC MOLDING PRESSES from 15" x 18" to 32" x 36" platen surface, rams 9" dia. to 20" dia. ram, all with hydraulic pullbacks and slotted heads for die attachments. 1—W. S. Hydro-Pneumatic Accumulator 2500 PSI, 8 gal. with IR m.d. air compressor; 6—30" x 40" platen, 500 ton Hyd. Presses; 1—W.S. 15" x 18" Hyd. press, 9" dia. ram, 4" posts; 1—W. S. 24" x 48" Hyd. Press. 12" dia. ram, with hyd. pushbacks; 1—46" x 54" Hyd. Press, 19" dia. ram; 1—Bethlehem 38" x 78" Hyd. Press, 20" dia. ram; 1—Birmingham 24" x 36", 12" ram Presses, 3 openings. 1—H.P.M. 24" x 24", 10" ram Presses, 2 openings. 1—W. S. 12" x 12", 7½" ram. Royale #½ perfection Tuber. 7—W. & P. Mixers; Tablet Machines. Send for complete list. Reply Box 446, Modern Plastics.

HIGHEST PRICES PAID FOR PLASTIC SCRAP OR REJECTS, any form, Cellulose Acetate, Butyrate, Polystyrene, Acrylic and Vinyl Resins. Also Phenolic and Urea molding materials. We do Custom Grinding and Magnetizing. Reply Box 476, Modern Plastics.

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WANTED: Compression and injection molding Acrylic Scrap. Any form or color. Send samples. Reply Box 579, Modern Plastics.

WANTED—Tool and die maker with experience in small stamping, punching, or plastic moulding dies. Permanent opportunity with a future. Salary to match qualifications. State qualifications and experience. Reply Box 520, Modern Plastics.

FOR SALE: About 50,000 lbs. 80 mesh prime quality Argentine Casein. Immediate shipment from New York stock. Reply Box 521, Modern Plastics.

FOR SALE: 2—600 Ton Horiz. Hydraulic Extrusion Presses. 1—30" x 60" Hydraulic Press 14½" dia. ram, 175 tons. 1—12" x 12" platen Hydraulic Press—10" ram—118 tons. 1—Southwark Triplex Pump—1.64 Gals. Hydraulic (2000 lbs.) 1—Hydraulic Press Mfg. Co. High and Low pressure Pump—Low 2.31 Gals. Hydraulics (750 lbs.) High—.60 Gals. Hydraulics (4250 lbs). 1—5H.P. Western Elec. Motor, Single Phase 1200 RPM. Reply Box 522, Modern Plastics.

ACTIVE or INACTIVE INVESTOR WITH $100,000 can have controlling interest in very profitable business not affected adversely by labor or war restrictions, relative to Art, Advertising, Mail Order, the Educational and Plastic Situation and Reproduction Processes. Reply Box 523, Modern Plastics.

SALES REPRESENTATIVES WANTED for extruded plastic shapes on Eastern Seaboard, Middle West and West Coast. Prefer men already selling molded plastic products or kindred items. Reply Box 524, Modern Plastics.

INJECTION AND HIGH COMPRESSION TOOL, MOLD MAKER executive ability, well grounded in the design of injection and high compression molds, dies, tools and fixtures, desires to contact a firm or organization which is interested in acquiring a top notch tool maker that knows most of the practical side of mold making for real efficiency. Willing to locate anywhere. Reply Box 525, Modern Plastics.

SITUATION WANTED by young man, draft deferred, now employed by molder.
1. With compression-injection molder or caster.
2. Experiment with new applications for plastics materials.
3. Evening study work.
4. Steady employment.
5. Employer who is interested and who takes personal interest in employees' welfare. References. Reply Box 526, Modern Plastics.

AFTER-THE-WAR PRODUCTS WANTED NOW

Machinery to manufacture for new processes or unusual products having exceptional marketing possibilities. Assistance such as research, engineering, etc., might be furnished to develop the product or machinery now. Our client has retained us to investigate and recommend propositions. It is a PROGRESSIVE COMPANY, having highest financial rating and a modern plant. It is all out to win the war. It wants and will make an all out effort to keep its present organization and employees after Democracy is safe. Propositions submitted will be considered confidential.

BARKLEY ASSOCIATES
538 Commonwealth Avenue Boston, Massachusetts

WANTED: AN EXPERIENCED EXTRUSION ENGINEER to take complete charge of operation of extrusion department. Reply Box 527, Modern Plastics.

tistical committee will survey the community's plastics industry and analyze information for presentation to OPM and Army and Navy procurement agencies. A preliminary survey made by this committee shows the amounts of different plastic materials used during the first nine months of 1941, the varieties of work done in the plants, the kind and amount of machinery in use, etc., and gives a complete list of articles produced.

The engineering committee, whose duty it is to locate war work, has already made contacts with OPM; with the Quartermaster Corps, Chemical Warfare Service and Ordnance Department of the Army; and with the Navy bureaus. It scrutinizes invitations to bid and prime contracts let for items which can be produced either by individual manufacturers or by the group on a pooling basis, and recommends feasible substitutions of plastics for metal or rubber.

The Plastics Manufacturers Group hopes to accomplish two objectives: first, to assist the Government in the war effort; and second, to prevent its community from becoming a ghost town through mass unemployment in its plastics industry.

★ A SYMPOSIUM ON "VISCOSITY, MOLECULAR SIZE and Molecular Shape" is to be held under the sponsorship of the Society of Rheology at the Brooklyn Polytechnic Institute on Feb. 20 from 10:30 A.M. to 5:00 P.M. Dr. M. L. Huggins, Eastman Kodak Research Dept., will speak on "Theoretical Fundamentals concerning the Connection between Viscosity, Molecular Size and Molecular Shape." Dr. M. A. Lauffer, of the Rockefeller Institute for Medical Research, will discuss "Experimental Methods and Facts."

★ NEW VICE-PRESIDENT OF MAKALOT CORP., Boston, is C. R. Olson (above) who for the past four years has managed the company's midwestern business. A native of Rockford, Ill., Mr. Olson spent twelve years in the banking business before he switched to the plastics field, entering the plastic-molding department of the National Lock Company.

★ STERLING PLASTICS CO., CUSTOM MOLDERS, HAS moved into its new plant at 1140 Commerce Ave., at Vaux Hall Rd., Union, N. J.

★ FREYDBERG BROS., INC., OF 212 FIFTH AVE., N. Y., manufacturers of plastic-covered yarns, have announced that their firm will henceforth be known as Freydberg Bros.-Strauss, Inc. Beginning as makers of bias bindings, the company, which celebrates its 45th anniversary this year, branched out into novelties, ribbons, trimmings and finally into the field of plastic yarns, cords and tapes.

★ THE ALL-AMERICAN PACKAGE COMPETITION sponsored by *Modern Packaging* magazine opened for the 11th consecutive year on Jan. 20 at the Grand Central Palace, New York City. More than 20,000 packages on exhibit are classified this year according to the industries represented by their contents—24 in all. Over 2500 exhibitors from the United States and Canada are represented in the exhibit, which will be open to the public through March 10. Awards will be made in April.

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MUST EARN THE RIGHT

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Under the critical eyes of Clover engineers and chemists, the manufacture of Clover Coated Abrasives is a routine of rigid control. Nothing is left to chance. And before the finished product can leave the Clover Plant, it must prove by actual performance tests that it can do the work for which it is recommended. Only in that way can it earn the right to carry the *Mark of Clover Quality.*

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THE REMARKABLE VERSATILITY OF SINKO INJECTION MOLDINGS

More and more perplexing metal shortage problems are being solved very successfully by Sinko Injection Moldings! Plastics are so versatile they can be adapted to many different needs. For instance, certain plastics prove more satisfactory for vending and processing machine parts that come in direct contact with foods, such as those illustrated. These are a recent switch-over from metal to plastic.

The long experience and resourcefulness of our engineers may prove just as valuable to you as they have for other manufacturers. Whether your requirements call for a simple injection molding or an intricate metal reinforced job, submit your ideas or designs to our competent staff for suggestions and moderate cost estimates. There's no obligation. Just call in our nearest field representative, or write.

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PRECISION INJECTION MOLDING

SINKO TOOL AND MANUFACTURING CO.

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Government and Industry

★ MANUFACTURERS OF MACHINE TOOLS AND other metal-working equipment who have been securing the necessary materials with the assistance of the A-1-a, A-1-b and A-1-c ratings authorized by Preference Rating Order P-11-a, will continue to receive this help until March 15, 1942, under the terms of an extension of the order, announced Jan. 1 by the Priorities Division.

★ LIMITATION ORDER L-20 RELATIVE TO CELLOphane and similar transparent cellulose-derived materials was amended on Jan. 11 to put 14 additional uses of these materials under the ban. The original order applied to only 10 general categories. The amendment does not apply to stocks in users' hands on or before Jan. 8, nor to stocks treated in such a way prior to that date that they cannot be used by those unaffected by the order. Defense orders (as defined) and defective stock are also exempt. The materials affected by the order are defined as "cellophane or similar transparent materials derived from cellulose having a gage of less than .005 in." They are not to be used, according to the order, for packaging or manufacture of (partial list): Razor blades, cosmetics and soap, textiles, rubber products, hardware, sporting goods, paper products, jewelry, bottled food and drink, flowers, decorations and novelties, cigar and candy boxes, cigarettes (except where tinfoil is not used) and plastic products. Appeals from the order, which expires Feb. 15, should be made to the Chemicals Branch, W.P.B. Basic war chemicals used in manufacture of cellulosic wrappings include chlorine, phenol and glycerin.

★ IN ORDER TO FACILITATE THE INCREASED PRODuction of acetone, butanol, and ethyl alcohol from corn, a high-cost raw material, the Office of Price Administration has acted to increase its ceiling prices for these three basic industrial chemicals, Administrator Henderson announced Dec. 20. The new maximum price levels, contained in temporary amendments to each schedule and effective Jan. 1, 1942, also recognize the increase that has taken place in molasses prices and provide for a sliding scale, based upon the cost of raw molasses, when that material is used to make acetone, butanol, and ethyl alcohol.

★ THE SYNTHETIC RUBBER ORDER, M-13, WAS amended and extended on Jan. 2 to include types of synthetic rubber developed since the original order was issued, and to extend the order indefinitely. Production of synthetic rubber is expected to reach a yearly rate of 140,000 tons by the end of 1942. Practically all of last year's output—about 12,500 tons—is going into self-sealing gasoline tanks for airplanes, tank linings, etc.

★ A PREFERENCE RATING B-8 HAS BEEN ASSIGNED by Amendment No. 3 to General Preference Order M-31 to deliveries of methyl alcohol, under certain specified conditions, to persons who require it for general denaturant and solvent uses.

★ THE PRIORITIES DIV. OF OPM ON JAN. 5 ANnounced Amendment No. 1 to Preference Rating Order M-10 (the polyvinyl chloride order), which extends the effective term of the order indefinitely. No other substantive changes are made.

★ PRIORITY REGULATIONS GOVERNING THE PRODuction and distribution of titanium pigments are clarified by Amendment No. 2 to General Preference Order M-44 issued Jan. 7 by the Director of Priorities. Order M-44 provided that no producer should sell or deliver titanium pigment to any manufacturer unless he had first received from the manufacturer a certificate covering the manufacturer's monthly requirements for the month in which deliveries were to be made. Titanium pigments, used in the coloring of phenol-formaldehyde plastics and aldehyde coatings, were formerly imported from India and Norway.

★ BECAUSE OF THE IMPORTANCE OF AN ADEQUATE supply of hand flashlights for the use of householders during air-raid blackouts, their production has been placed in Classification 1 of Preference Rating Order M-25. This means that deliveries of synthetic formaldehyde resins for their manufacture are covered by a B-4 rating, the highest civilian rating authorized by the order. Amendment No. 5 to General Preference Order M-25, issued Dec. 31, 1941, by the Priorities Division, also extends the order, which would have expired on that date, indefinitely.

★ A CONSERVATION CONTROL PLAN FOR U. S. INDUStry has been worked out by Henry Disston & Sons, Inc., Philadelphia, which they believe will save vital materials and speed up production. The plan is based on a series of conservation control cards, one for every cutting tool used by mechanics in plant shops. Each card lists the types of failure to which that particular tool is subject, together with their causes, and gives precise instructions on how failure may be avoided or corrected. Follows a list of recommendations on how to get the best results from the tool. With increased production, Disston feels, there are not enough foremen to oversee the additional workers, many of whom are inexperienced; and these control cards provide individualized instruction and multiply supervision. Disston will supply the cards without cost to any interested firm, together with posters, buttons and other material for developing the plan, of which the OPM says: "It reflects precisely what we would have every industrial plant in the country undertake."

★ A TOTAL OF 48 PERMANENT EXHIBITS WILL BE operated by the OPM in as many industrial centers to facilitate subcontracting of items to be used in the war effort. Hundreds of these items will be displayed by holders of large war contracts and by the Army, Navy and the U. S. Maritime Commission, and will be replaced by others as they are put under contract. A representative of the Contract Distribution Division will be on hand to advise manufacturers who believe they can make the items exhibited. A list of cities in which these exhibits will be set up, and dates of their opening, may be secured from the OPM.

★ WHY THE WAR IS CAUSING A LITERAL FADEOUT of the American spectrum is briefly explained by the Color Research Laboratory of Eagle Printing Ink Co., a division of General Printing Ink Corp., 100 Sixth Ave., New York City. Printing inks, pigments and dyestuffs, their news letter points out, are unavailable because substances from which they are derived are needed for materials of war. Chromium ore, source of most yellows, is used in armor plate and stainless steel; naphthalene (reds) goes into the manufacture of smokeless powder and military and marine paints; metallic pigments made from aluminum, copper and brass are scarce for obvious reasons. Zinc, nitric acid, phthalic anhydride, aniline, chlorine, formaldehyde—all of them used in the production of colored inks and pigments—have important functions to perform in the rearmament program. Plastics manufacturers who are accustomed to wiping-in color on their products or to using color in other ways may have to sacrifice some decorative effects until coloring materials supplies are more available.

★ THE EXECUTIVE COMMITTEE OF THE AMERICAN Society of Tool Engineers has approved a plan for mobilizing the services of the organization's 10,000 members. The experience and ability of each man will be listed, and the geographically arranged lists made available to local and centralized units of Federal production, educational and control agencies, which can thus locate immediately tool engineers having specific experience with problems on which assistance is needed.

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as wanted

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where wanted

in your plant; as moulded; as assembled; as finished

how wanted

for quick changes of imprint on variable quantities; for long and short runs

with equipment to fit the job

is simply a matter of sending *complete* details of your marking problem. Samples, if available and sent to us, are marked and returned, with recommendations of method and equipment to duplicate our work in your plant. If inquiry concerns a war order, please state applicable priority rating.

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make certain that your molder is MARKEM equipped

Plastics meeting in Washington

by GUS HOLMGREN*

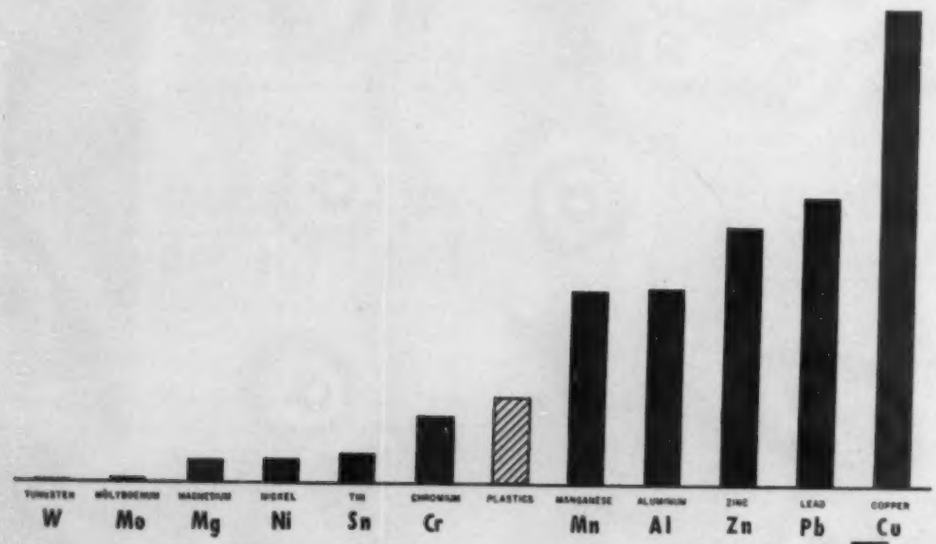
A PLASTICS meeting co-sponsored by the Bureau of Industrial Conservation of the Office of Production Management and the U. S. Department of Commerce was held on Tuesday evening, Dec. 16, 1941, at the Department of Commerce Auditorium. More than 300 representatives of the Army, Navy, OPM and various other Government agencies attended.

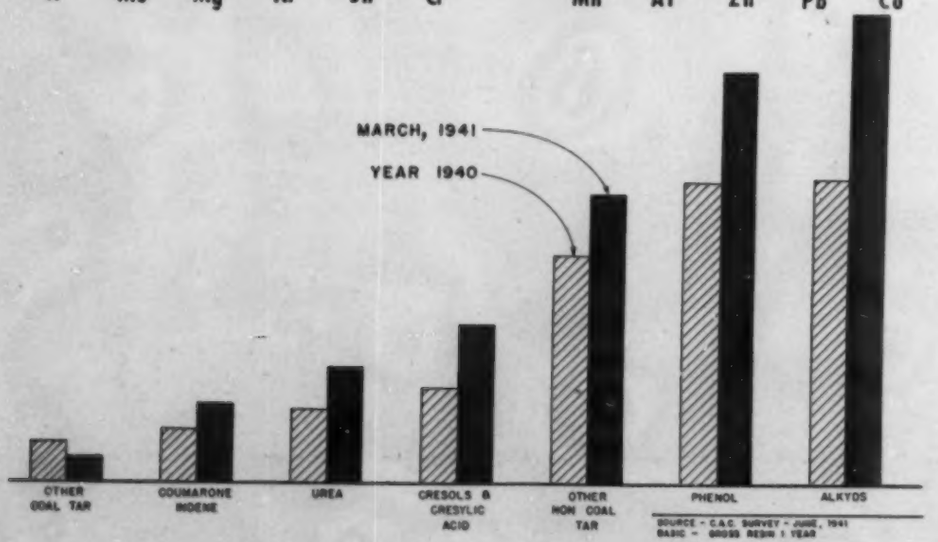
The meeting was opened by Wayne Chatfield Taylor, Under Secretary of Commerce, who welcomed the group, emphasizing the desirability of such a gathering and stressing the interest of the Department of Commerce in playing an active part in view of the importance of plastics in the war program and the rôle they will probably play in the post-war era. He then introduced Lessing J. Rosenwald, Chief, Bureau of Industrial Conservation, OPM, who served as chairman of the meeting.

Mr. Rosenwald pointed out that the interest of his Bureau in plastics was from the standpoint of replacement of more critical materials and conservation of the most critical plastics He called attention to the exhibit in the auditorium, consisting of over 700 different plastic items, each playing a part in the war program and representing practically all types of plastics and fabricating processes. He also advised that a committee of plastics application and replacement had been proposed. This committee, to be made up of men designated from each branch of service, was designed to act as a clearing house for ideas, information and to promote proper conservation of all vital materials.

Major C. V. Morgan, Chief, Commodities Division, Army and Navy Munitions Board, graphically (see charts on these pages) showed the wide scope of applications of plastics and the relative position in pounds production as compared to some of the metals which they can well replace. He stressed the fact that if plastics were to play an important rôle in relieving critical metals and other materials, a sizable increase in plastic raw materials production would be necessary. Plas-

* Bureau of Industrial Conservation, Office of Production Management.





1—Estimated national supply, 1942 plastics and various metals. 2—Relative plastics production, 1940, versus March, 1941, rate. (Both charts were prepared in the Commodities Division, Planning Branch, O. U. S. W.)

Specially-designed agitators for EASY Spin-drier Washers, major award winner in the 6th Annual "Modern Plastics" Competition, were molded with Carpenter Mold Steel by Eclipse Molded Products Co.

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Right now, getting the most out of every pound of mold steel you use is more important than ever before. To help you do just that—by simplifying the selection and heat treatment of the mold steel for each job, we have prepared a 36-page booklet—"Tooling Up for Plastics". Its helpful hints on steel selection and heat treatment can save time and money for mold makers, and mean better results for molders. If you do not have a copy of "Tooling Up for Plastics", a note on your company letterhead will start a copy on its way to you. This offer good only in U. S. A.

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While your plant is busy helping win the war look into the possibilities of moulded plastics. It may be your salvation tomorrow.

We welcome your inquiries whether for immediate production or for future development. Maybe we could simplify the manufacture of your product—give it more color and sales appeal. Maybe it can be made less expensively through moulding.

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tics material manufacturers representing over 50 percent of existing plant capacity reported in a recent survey that the majority was favorable to expanding production still further provided materials and equipment were made available. The tables and charts which Major Morgan used to illustrate his talk have been released for publication as part of this report. The data were obtained in a survey made in June 1941 by the Chemical Advisory Committee of the Army-Navy Munitions Board and were compiled in the Commodities Division, Planning Branch, Office of Under Secretary of War.

Dr. Gordon M. Kline, Chief, Organic Plastics Section, National Bureau of Standards, reviewed the work being done by the Bureau with particular emphasis on the development and research work in connection with the victory program. In illustration of this work he told of tests run on plastic window material made by laminating cellulosic foils with cotton or paper scrim. Accelerated tests revealed that free chlorine in the paper promoted rapid deterioration. Weathering and bursting strength tests showed that the most suitable ma-

PLASTICS EXPANSION—1941
Base—1940 Production = 100

Type of Plastic	*Annual Cap.—Mar. '41*	*Annual Cap. + Planned Exp.*
Abrasive and friction elements		
All types	210	275
Adhesives and cements		
Phenol	250	370
Urea	380	485
Other	210	240
Brake linings		
Phenol	225	362
Other	290	420
Cast resins		
All types	185	200
Laminated and impregnated		
Cresol	220	280
Phenol	300	380
Other	260	390
Molding material		
Cellulose acetate	185	225
Phenol	170	200
Polystyrene	290	1300
Other	160	265
Paint and varnish		
Alkyds	200	280
Butyl-phenol	230	290
Phenol	220	290
Urea	365	425
Other	155	215
Sheet, rod and tube		
Cellulose acetate	155	165
Cellulose nitrate	140	145
Other	200	315
Miscellaneous		
Phenol	195	215
Urea	260	260
Other	145	170

TYPES OF RESINS GOING TO VARIOUS END USES

Type of Resin	*Abrasives*	*Adhesives*	*Brake Linings*	*Cast Resins*	*Laminating*	*Molding*	*Paint and Varnish*	*Sheet, Rods, etc.*	*Miscellaneous*
Acrylic		x		x	x	x	x	x	x
Alkyds	x						x		x
Amyl-phenol							x		
Bisphenol							x		
Butyl-phenol							x		
Casein		x						x	x
Cellulose acetate						x		x	x
Cellulose esters (other)		x				x	x	x	
Cellulose nitrate							x	x	
Coumarone-indene							x		x
Cresol	x	x	x		x	x	x		x
Cresol and phenol								x	
Cresylic acid			x		x	x	x		
Melamine		x			x	x			
Phenol	x	x	x	x	x	x	x		x
Phenyl-phenol							x		
Polystyrene						x			
Terpene phenol							x		x
Urea		x			x	x	x		x
Vinyl		x				x	x	x	x
Xylenol			x		x	x	x		

PLASTICS PRODUCTION (Summary—All Plastics. Unit—1000 Pounds)

No. of Producers	*Type of Plastic*	*1940 Production*		*Yearly Rate Production March 1941*		*Estimated Maximum Yearly Capacity*[1]		*Expansion Planned Yearly Production*[2]	
		As Reported	*Estimated Net Resin*	*As Reported*	*Estimated Net Resin*	*As Reported*	*Estimated Net Resin*	*As Reported*	*Estimated Net Resin*
7	Abrasives	3,972	3,816	7,223	6,963	8,364	8,031	2,560	2,460
17	Adhesives	19,055	16,010	27,019	22,209	54,994	44,970	14,612	11,617
6	Brake linings	4,978	3,236	9,833	6,389	12,391	8,050	6,590	4,280
7	Cast resins	7,315	7,315	10,267	10,267	13,401	13,401	1,619	1,619
18	Laminating	34,431	20,757	60,088	36,222	82,632	49,912	26,003	15,774
28	Molding	128,732	72,304	182,211	104,114	221,931	126,363	86,337	62,918
65	Paint and varnish	199,919	129,890	282,807	193,966	393,410	258,179	146,824	102,934
15	Sheets, rods, etc.	40,837	30,967	54,209	41,704	67,884	51,531	18,750	14,879
20	Miscellaneous	26,331	24,604	34,586	32,926	42,138	39,439	6,807	6,807
	TOTAL	465,570	308,899	638,243	454,760	897,145	599,876	310,102	223,288

[1] As of June 1941, without capacity given under "Expansion Planned."
[2] As of June 1941. *Note: All tables on this page prepared from survey made through Chemical Advisory Committee, A.N.M.B.*

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for QUALITY PLASTIC MOULDINGS!

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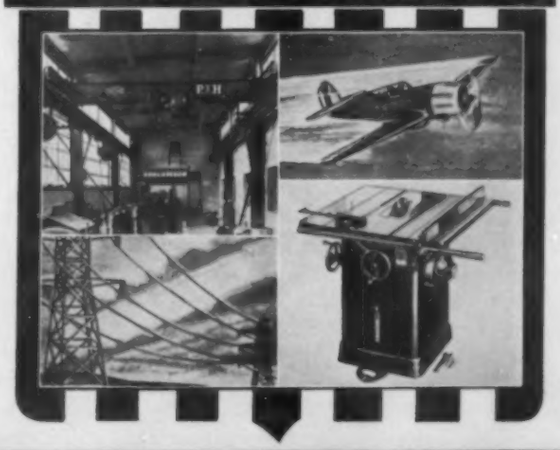

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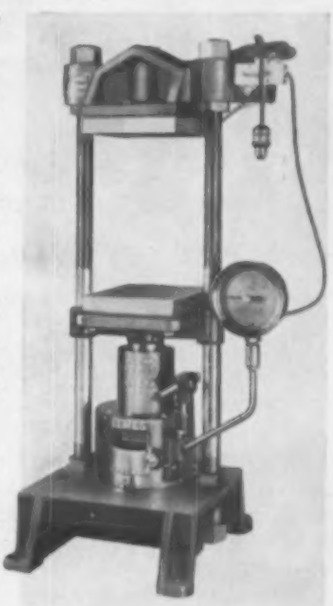

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ELMES

PLASTICS—SELECTED RAW MATERIALS REQUIRED BY THE PLASTICS INDUSTRY FOR OPERATION AT MAXIMUM CAPACITY

As of June 1941

Surveyed through Chemical Advisory Committee, A.N.M.B.

Raw Material	*Requirements (1000 Pounds)*	
Cresols and cresylic acid		44,923
Formaldehyde		
As 40% solution	256,498	
As hexamethylenetetramine	23,600	
As paraformaldehyde	3,036	
Total		283,124
Glycerine		40,552
Maleic acid and anhydride		5,540
Phenol		125,618
Phthalic anhydride		68,458
Urea		42,147

VARIOUS PLASTIC RAW MATERIALS
RELATIVE REQUIREMENTS AND SUPPLY

Requirements as of June 1, 1941
Unit—1000 Pounds

Raw Material	*Plastic Requirements*	*Production Rate*	*Capacity*
Cresols and cresylic acid	45,000	48,000 (9–41)	55,000 (9–41)
Formaldehyde	283,000	288,000 (6–41)	370,000 (10–41)
Glycerine	41,000	186,000 (9–41)	240,000 (9–41)
Phenol	126,000	125,000 (9–41)	133,000 (11–41)
Phthalic anhydride	68,000	83,000 (9–41)	84,000 (11–41)

Source: Chemical Advisory Committee Reports.

terial will probably be made with cellulose acetate or cellulose acetate butyrate sheet. Another example was the extensive tests run on plastic coatings for metal to evaluate them for military applications.

Dr. Kline also outlined some of the Bureau's work aiding in the development of new materials as well as of extenders for standard materials. In this category they have run extensive tests on soya bean, lignin and bagasse molding materials, in all of which phenolic resins were employed. These materials are significant at present in view of savings in critical raw materials that can be effected. The lignin and bagasse materials hold the most promise in that they make possible the greatest savings of phenolic resin.

Eugene Vidal, former Director, Bureau of Air Commerce, explained one of the methods of forming plastic-bonded plywood in various shapes for airplane parts, boats, skis, pontoons and similar items. He advised that they were enlarging upon their applications but that they had hardly touched upon numerous possibilities. Many of these will probably be held in abeyance until the post-war period since their activities are at present concentrated upon military applications.

Mr. Vidal pointed out some of the advantages of plastic-bonded plywood, such as high strength-weight ratio, latitude in producing curved surfaces and in production of large parts. He suggested its use as an ideal replacement material in view of the small percentage of critical ingredients involved. The plastic bond may constitute only 6 or 7 percent of the total. Mr. Vidal at present is associated with the Aircraft Research Corp., which controls the Vidal process.

At the conclusion of these talks, the meeting was thrown open for discussion, after which further opportunity was given to examine the exhibits.

Dressing table jewels

(Continued from page 39) characters exceptionally clear-cut down to the finest detail. Deepest cuts are approximately one-quarter of an inch. The photograph cannot do justice to the skill and artistry displayed by the mold—the tassels on the flagpole, the bayonets on the rifles, the tiny fingernails and even the grain in the wood of the boat's sides. Molds for the other plastic articles found in the vault were similarly hand engraved, with birds and flowers in minute detail figuring prominently in the designs. As a matter of curiosity, the old dies were taken to the molding room, fitted into a press, and a charge of cellulose acetate molding compound placed in the form. The hand mirrors shown on page 38 were the result; and the Victorian dresser sets now manufactured by the company in modern pastel shades are made in these very dies.

Compression molding of thermoplastics has been done on a large scale by Pro-phy-lac-tic for many years. More recently this department has been turned over to the thermosetting type of resins. The company intends to enter the custom molding field, both compression and injection.

As its part in the nationwide industrial mobilization for victory, the company reports it is now making molds for a large thermoplastic piece for military use, soon to go into production, which is particularly suited to its set-up of 12 and 16 oz. capacity injection presses; and that Army mess-kit knife handles are now being molded by compression. Side by side with its war work, however, a program of improvement and expansion is going on, looking forward to the time when limitations on plastic materials are removed.

Credits—Material: Crystalite by Röhm and Haas Co.; Fibestos by Monsanto Chemical Co. Jewelite brushes, combs, etc., by Prophy-lac-tic Brush Co. Coltstone jewels by Colt's Patent Fire Arms Mfg. Company.

Double talk on the record

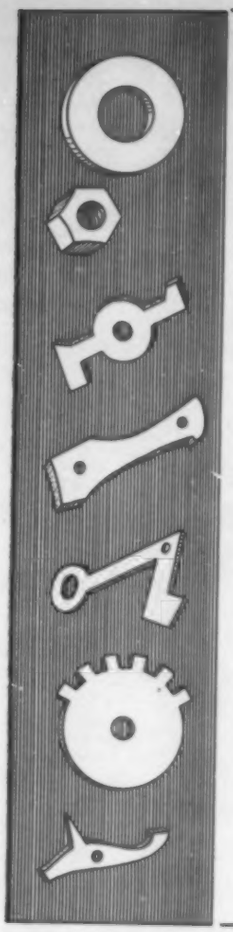
(Continued from page 42) tactical and command communications; reconnaissance recording, at the receiving end, of observations made in staff cars or in scouting planes; radio logging to record all vital programs for reference and to monitor enemy civilian broadcast stations so that propaganda may be recorded for analysis.

In the business and industrial field, the machine may be used to record long interviews, meetings; and as a modern office dictation instrument. More convenient than the conventional dictation machine, the device is simple and economical to operate, space-saving and versatile.

The background of the manufacturer in the production of telephone pay stations, acoustical devices and in the development of an economical method of molding flexible plastic record duplicates introduced some time ago* is part of the history of the Audograph. The research of the material supplier in cellulosic films, experimental work with vinyl and ethyl cellulose (which proved either too brittle or too soft) led to the final acceptance of the cellulose acetate disk.

Credits—Audograph and Flexograph records by Gray Manufacturing Co. Cellulose acetate sheeting by Eastman Kodak Company

* Molded modulation recordings, MODERN PLASTICS *18*, February 1941, page 36.



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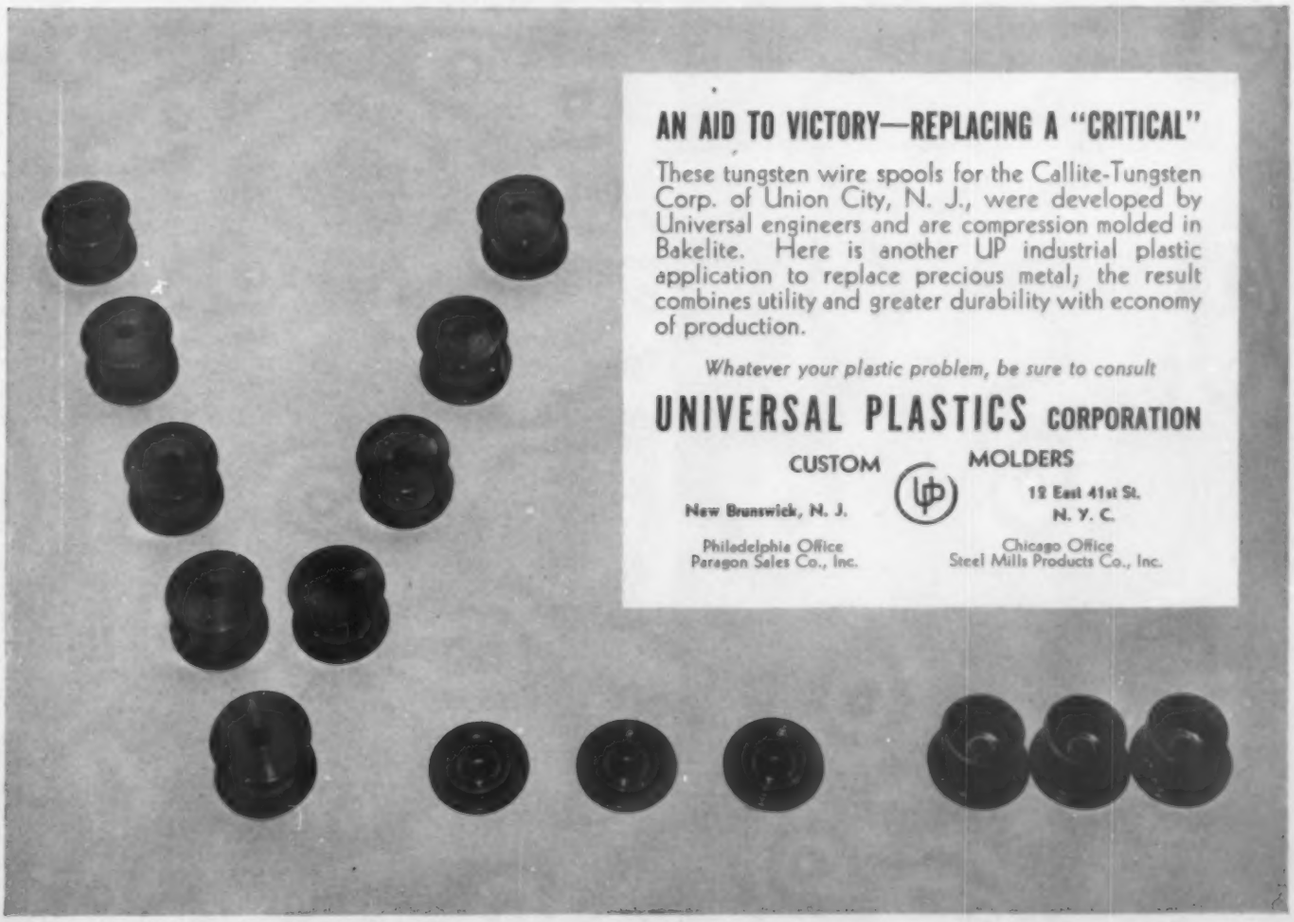

AN AID TO VICTORY—REPLACING A "CRITICAL"

These tungsten wire spools for the Callite-Tungsten Corp. of Union City, N. J., were developed by Universal engineers and are compression molded in Bakelite. Here is another UP industrial plastic application to replace precious metal; the result combines utility and greater durability with economy of production.

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Urea plastics in lighting

(Continued from page 65)

intensity of illumination and a = angle of incidence from the normal. When these are expressed in candles per square inch and footcandles, k becomes 2.15×10^{-3} for 500-watt lamps. This constant should not vary for larger or smaller lamps, but it can be evaluated for any specific condition by solving the equation for k, using the known numerical values of B, T, I and a.

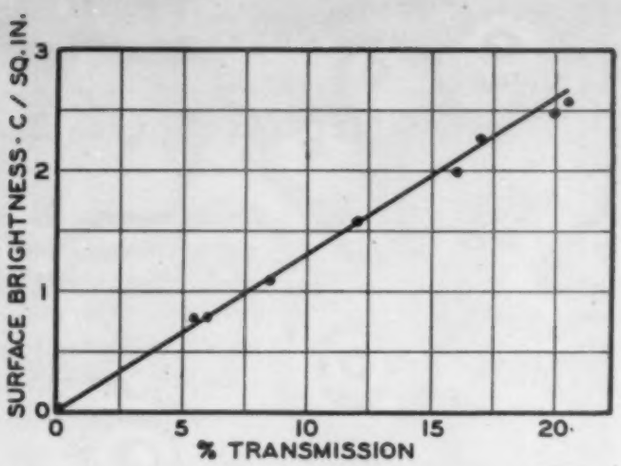
A test made on a commercial design checked the above equation, less the cosine function, with a fair degree of accuracy. The reflectors were molded from a range of plastic formulations to obtain several opacities. Readings made when the moldings were hung at the correct distance from a 500-watt lamp operating at constant rated voltage are plotted in Fig. 13. The incidence of the light was normal to the surface and its intensity was 6100 footcandles. The equation in this case was therefore:

$$B = 2.15 \times 10^{-3} \times 6100\ T$$

The thickness of the molding does not enter into the calculations as a separate term since it is included in the transmission factor. Extremely thin moldings would probably not follow the equation since the decrease in section would also decrease the diffusiveness of the material.

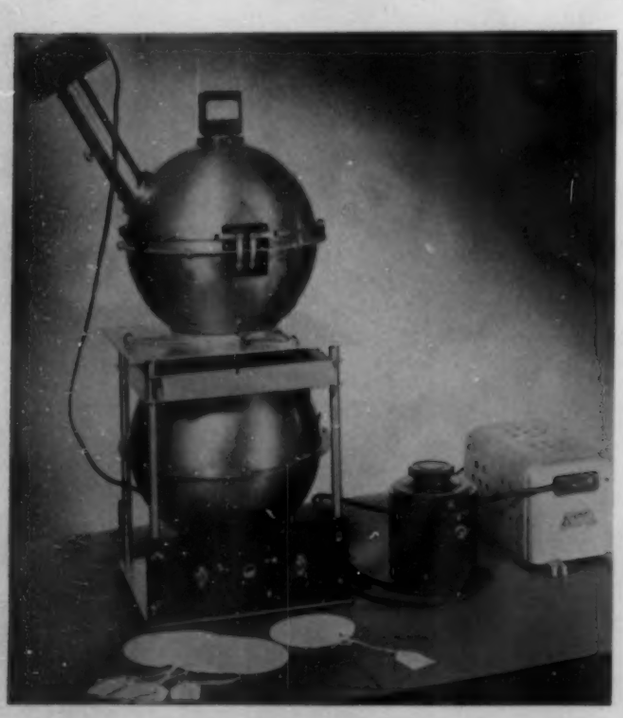
The expected surface brightness of any given fixture for lamps of other wattages can be computed roughly by multiplying the brightness for one by the ratio of the total lumen output of the two lamps. Accuracy of such values is satisfactory for visual purposes.

Measurement of the incident footcandles and the transmission factor for the equation given above is relatively simple. The photocell of the footcandle meter is exposed through a hole cut in the test reflector (molded in the desired design or even reproduced in white cardboard[1]) to read the normal light intensity. The transmission factor of the sample is obtained by placing the meter in general artificial illumination strong enough to give a reading near the top of its scale and then covering the photocell with the sample to take the reduced reading. The ratio of the two figures is the transmission factor.



13—*Surface brightness versus percent transmission for 19 by 7¾-in. reflector and 500-watt lamp at safe spacing*

14—*General Electric reflectometer measures transmission and reflection factor. Samples are placed between spheres*



For more accurate results, transmission factors are measured in this laboratory on the General Electric reflectometer[2] illustrated in Fig. 14. In this instrument the lower sphere provides completely diffused light which passes, either directly or through the sample, to the upper sphere, where photocells measure the amount of light transmitted. Reflection factors can also be measured, employing only the upper sphere and a collimated beam of light which can be made to fall either on the white inner surface of the sphere or on the sample at the bottom. Table II compares transmission measurements made on three white plastic samples with the reflectometer and with a footcandle meter. The correlation is good considering the low precision of the footcandle meter.

The validity of the cosine factor in Equation 1 was tested for numerous formulations and thicknesses of plastic. Figure 15 gives a typical set of curves for one kind of material. These curves demonstrate that, as the angle of incidence increases, the surface brightness of the opposite side of a diffusing substance is reduced according to the cosine of the angle. Intelligent handling of this variable permits accurate control of surface brightness at flared surfaces and in areas where rapid changes occur in the angle of incidence.

For routine measurements of surface brightness the procedure described above is too tedious. A brightness meter gives surface brightness values directly. Comparison tests with a Luckiesh-Taylor type brightness meter confirmed the validity of the indirect method. *(Please turn to page 98)*

TABLE II. TRANSMISSION MEASUREMENTS MADE BY G. E. REFLECTOMETER AND A FOOTCANDLE METER

Sample	Reflectometer	Footcandle meter
1	.050	.060
2	.140	.150
3	.360	.380

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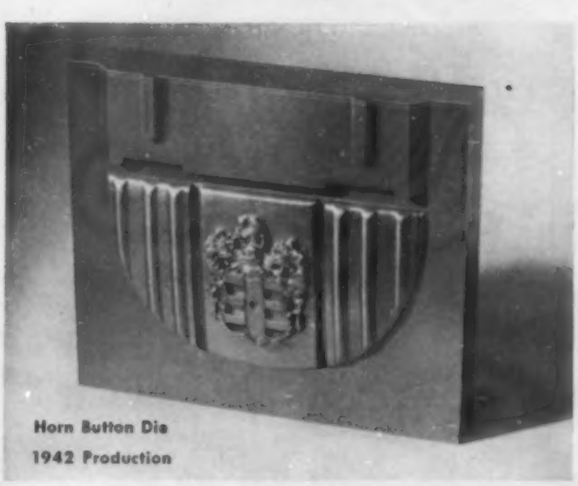

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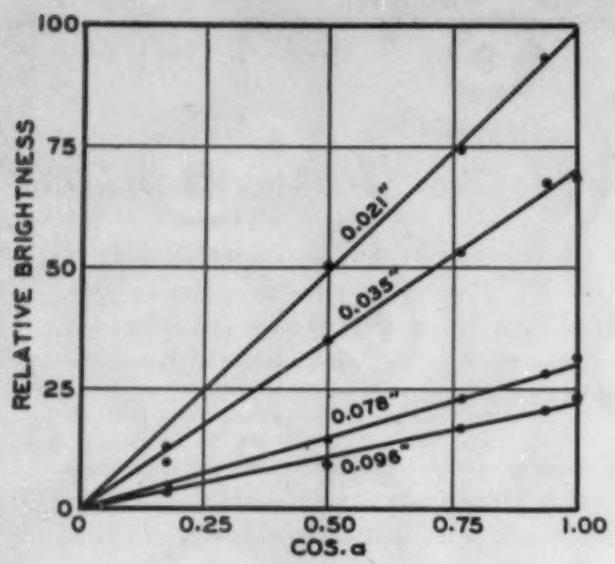


15—*Curves showing experimental relationship between surface brightness and Cos. a*

Transmission, reflection and efficiency

For any desired thickness of molding, the transmission factor, and with it the surface brightness, is controlled and adjusted by the material manufacturer by including a "white" opacifying pigment to scatter incidence light. The most commonly used are zinc sulfide and zirconium dioxide.

Figure 16 illustrates graphically the relation between transmission, reflection and efficiency and the thickness and pigmentation of the material, with zirconium dioxide as the opacifier. The Lambert-Beer Law for transmission does not hold exactly for diffusing substances, as it is derived for nonscattering absorbers, but some similarity can be seen between the Lambert-Beer exponential and the lower curves of the figure. It is simpler to employ empirical graphical data as shown here than to attempt to apply the Beer formula, generally a tedious procedure.

The reflectivity curves derived from a modification of Beer's Law for transparent substances are likewise best used empirically. Values taken therefrom for a given set of conditions indicate the proportion of the total light that will be thrown upward.

Inspection of Fig. 16 shows that the efficiency of a molding is obtained by summing the reflection and transmission factors. Efficiencies obtained by reflection measurements on test samples of various materials check fairly well with results obtained on the finished reflector by distribution candlepower measurements made by a commercial testing laboratory. Some of these are tabulated in Table III.

The intrinsic visual efficiency of a fixture is determined by two factors: The dimensions of the molding design; and the specific visual absorbing power of the plastic. The first is controlled by the designer by his choice of molding thickness and dimensions, and the second depends on the weighted efficiencies of the components of the molding compound. In most cases the efficiency of the combined resin and cellulose fiber may be considered constant, despite usual small variations in resin-to-fiber ratio. The determining agents in the specific visual absorbing power of the plastic are, therefore, the pigments, both opacifying (white) and colored.

TABLE III. EFFICIENCY OF REFLECTOR MOLDING COMPONENTS

Sample	Efficiency: Reflectometer	Efficiency: Distribution candlepower
1	.855	.875
2	.845	.850
3	.755	.770

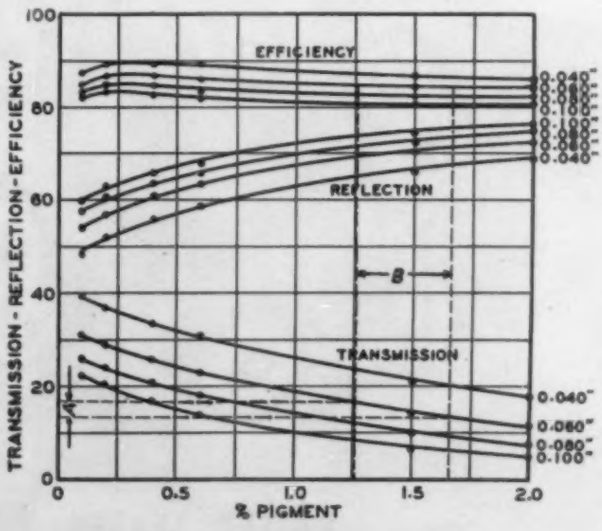
Color of fixture

Some commercially available urea molding formulations are modified by the addition of small amounts of colored pigment to give an ivory tint or to neutralize the natural pale ivory of an unpigmented mixture. Bluing the material to approach "dead white" has gained favor recently. The neutral, uncolored material, however, possesses maximum efficiency. Colored pigments always absorb part of the light that reaches them. Figure 17 shows spectrophotometric reflection and transmission curves for two samples of molded plastic (listed in Table IV) similar in all respects except that sample number two contains enough violet pigment to "whiten" it. The effect of the pigment is to absorb a small amount of light in the center of the spectrum, thus reducing the visual reflection and transmission factors—and hence the luminous efficiency—of the plastic. Any such inclusion affects the efficiency of the reflector to an extent dependent upon the amount and color of the pigment.

The additional light absorbed by coloring agents will cause an increase in the operating temperature of the fixture over one fabricated from unpigmented plastic. This increase is more pronounced for blue materials and decreases toward the red. Although pigmentation is usually so slight that the effect is not noticeable, strongly colored moldings show a marked increase in temperature which must be taken into consideration in using them in fixtures. Failure to do so may cause scorched areas or may fade the pigment.

Accuracy of physical measurements

Physical data quoted either in this paper or by material and fixture manufacturers have limited accuracy. Any laboratory adequately equipped for measuring the optical properties of the luminaire or of the plastic can determine reflection,



16—*Showing the relation between thickness and percent pigmentation and percent T, R and E for Zirox pigment*

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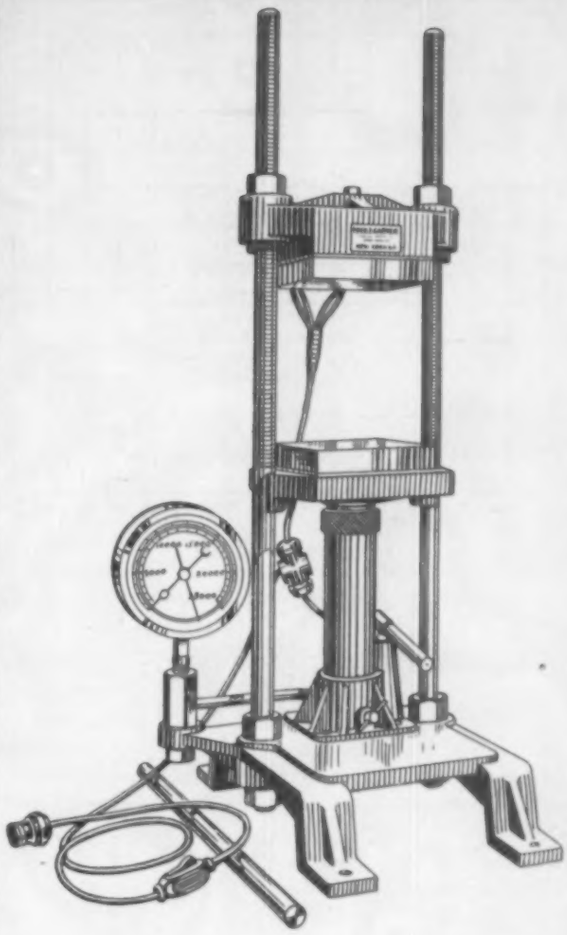

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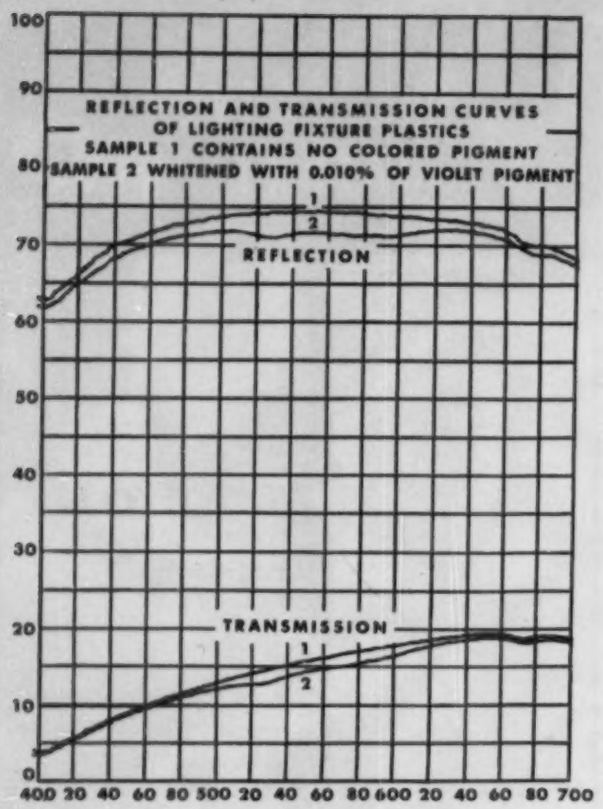

17—*Drop in reflection and transmission of molded plastic sample, caused by addition of 0.010% violet pigment*

transmission or efficiency of a specific piece within one-half of one percent with little difficulty. Samples from a production lot of the same design, however, may vary by one percent or more. Little meaning is, therefore, attached to measurements of efficiency of moldings to the third decimal place except in experimental and development work with laboratory batches which sometimes requires that degree of accuracy. Like limitations can be placed on variations in permissible surface brightness or color, although methods of producing urea molding material maintain these values closely from piece to piece. Nevertheless, the average person cannot select

TABLE IV. DECREASE IN EFFICIENCY OF FIXTURE MATERIAL CAUSED BY ADDITION OF PIGMENT

Sample	Pigment, percent	Thickness, in.	Reflection, percent	Transmission, percent	Efficiency
1	.000	.080	72.1	16.6	88.7
2	.010	.080	69.6	15.3	84.9

the brighter of two similar fixtures hung side by side unless their surface brightness differs by 20 percent or more.

The part which thickness and material formulation play in establishing the optical characteristics (reflection, transmission and efficiency) of a molding was noted above. These curves automatically control the limits of variation of these properties, depending, of course, on the type of opacifier used. If, for example, a certain design .060 in. thick, when hung safely must have 15 ± 2 percent transmission (A, Fig. 16) to obtain the required surface brightness, then 1.25–1.6 percent Zirox pigment must be included. The efficiency of the molding material will automatically be 83 percent (B, Fig. 16). These are the maximum values attainable under the conditions. Any added coloring agent will lower transmission and reflection, and therefore efficiency.

References

[1] G. R. Baumgartner, "Prediction of Lighting Performance of Plastic Mold Designs by Experimental Models," I. E. S. Transactions (September 1940).

[2] G. R. Baumgartner, "A Light Sensitive Cell Reflectometer," G. E. Review, pp. 525–7 (November 1937).

Walnut shell flour

(*Continued from page 37*) difference in cost of the filler to each of these companies is probably represented in the transportation charge. The distance between the General Electric Co. and the Agicide Laboratories is approximately 3500 miles, while the Baker plant is only about a mile away.

Comparison of price between walnut shell flour and wood flour would be futile because of present uncertain conditions and fluctuations, but it is reasonable to assume that the advantages of walnut shell flour are probably sufficient to more than offset the costs of transportation across the country, even at present freight rates. If this filler permits the saving of even 5 percent of the resin content in a molding compound through its low rate of absorption and lower specific gravity, it would seem logical to believe that the item of transportation cost would be small by comparison. At any rate, more than 4 million lb. of walnut shell flour is being absorbed per year by the plastics industry, or about half the total production at the present time.

Dynamite, insecticides, fur cleaning, latex ship decking, flooring, foundry dusting powder, etc., are products in which considerable quantities of walnut shell flour are used. Rubber takes a lot more. It is being used as a substitute for starch flour adhesives where it has the advantage of being fungus-proof. As a wood filler, the −325 mesh material enters the wood, seals the cracks and makes an extremely hard surface. For this purpose the filler is made as thin as water and may be applied with a cloth.

Another interesting use is for making high temperature insulation bricks. A coarse mesh (20–40) is mixed with clay and pressed into bricks. These bricks are placed in a kiln where the walnut shells are converted to carbon. When the temperature reaches a little more than 1600 deg. F., the carbon fires. As it burns, it gives off all its gas, and the burning of the carbon finishes the kiln. The ash in walnut shells is about $^3/_8$ of one percent and the air cells left in the bricks where the walnut shells burn out are spherical and uniform. These bricks are made to withstand 2500 deg. F. working temperature and the even, uniform size and distribution of air cells is important in preventing "creeping," which will cause disintegration. Such bricks are frequently used in battleships and heat-treating plants. The same material is used quite generally for making filters.

One of the most recent uses of walnut shell flour is in the latex type of flooring said to be used for battleship decks. The mixture is spread with a trowel and vulcanizes at room temperature. It has high resistance to electrical voltage; is resilient and nonslipping even when wet; and provides a lasting surface that stands a lot of abuse.

Since walnut shell flour can withstand concentrated sulfuric acid without much deterioration it is used as a filler in battery box material. In this application, walnut shell

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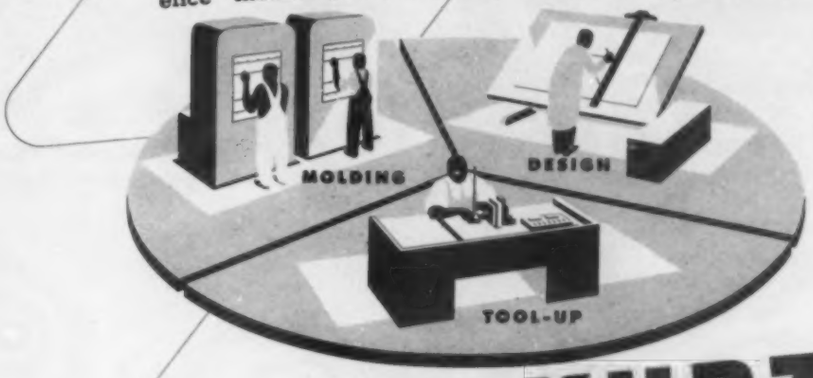

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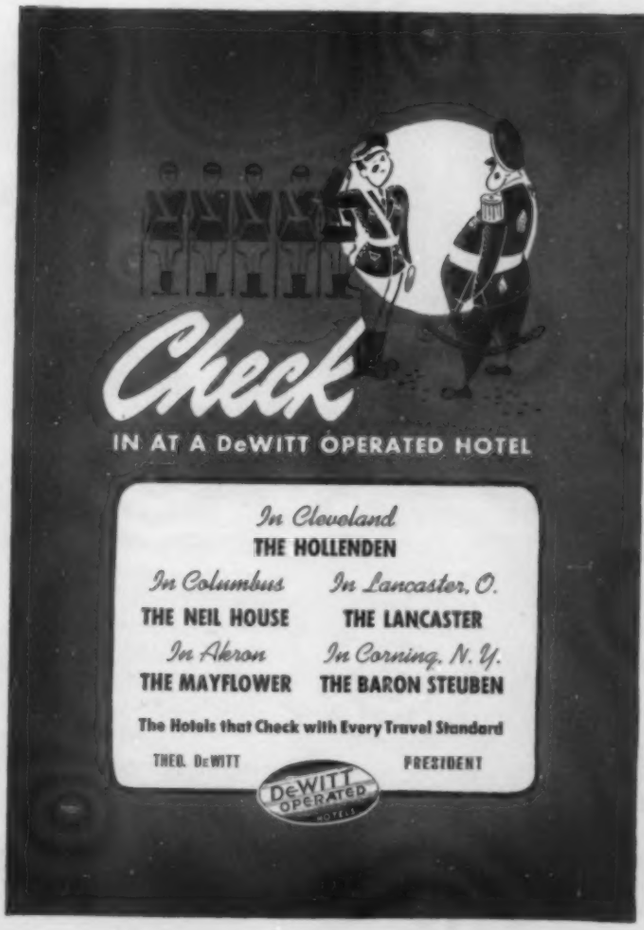

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flour is reported to show a special ability to improve the properties of vulcanized hard rubber. The product has a high shock resistance which prevents battery cases and covers from being broken easily.

It takes the place of lycopodium, too, which has been off the American market since the war began. Lycopodium is dust which comes from moss grown in Russia and sold, when it was available, at about $1.25 a pound. It is used to dust the core for very fine aluminum castings and forms a gas film when the hot metal is poured. This gas film contributes to the smoothness of the casting. Finely ground walnut shell flour does just as good a job as lycopodium, and sells at ten cents a pound. The high volatiles in the shells form a gas film just like lycopodium and accomplish the same result.

There are many uses of walnut shell flour that haven't been covered here, but just remember, the next time you crush a couple of walnuts together in your hand, that the part you throw away is the basis upon which a commercial business has been built. The business has grown to such an extent that a steel building, 60 by 182 ft., is being added to the present plant to take care of immediate demands. The conversion of by-product walnut shells into an important industrial material is a chemurgic development which has added appreciably to the income of the California Walnut Growers Association.

Flexible coatings for textiles

(*Continued from page 43*) come into much greater prominence and may even entirely replace oil, rubber *and* pyroxylin, since, in addition to waterproof and acid-resistant qualities, the synthetic resin finishes are strong, durable and nonflammable.

Availability and practical advantages have made the plasticized cellulose coating the current commercial leader in the field. This finish has for its base a nitrocellulose lacquer which is combined with various oils and plasticizers and applied to the fabric. The thickness and uniformity of the coating is controlled by a doctor blade on rubber type of spreading equipment. After passing through several operations which include drying and calendering, it is finally dusted with mica which takes up the tack and eliminates any possibility of sticking. This finish gives the material a film which not only protects it from water, oil, dirt and many acids but also adds an attractive sheen which, commercially, increases its sales appeal.

The finished, flexible coated fabric may be easily cleansed by wiping with a damp cloth or it may be laundered with mild soaps and may even be boiled without harm to the finish, the manufacturer reports. Like rubber, the coating can be pigmented to give the desired shade, or applied clear over a printed or colored material. Unlike rubber, the finish cannot be used to add various amounts of thickness to the merchandise coated. Weight is added and can be controlled to a certain degree, but the very heavy rubber finishes cannot be duplicated with this process.

Outside of the weight factor, the plastic-coated material is said to compare most favorably with the rubberized fabric. It is more lustrous, more resistant to varying temperatures, it will not stick, crack or harden, and—most important of all—it is not affected by aging. Time bomb tests are reported to show that a plastic-coated fabric after several years (measured by hours in the time bomb) is unaltered. Most rubberized fabrics would not withstand such a rigid test.

3—Easy-to-clean, water-repellant taffeta shower curtain is plastic coated on the inside. Similarly treated cotton pillow covers are a boon to down and feather allergy sufferers

Applications

In many cases where rubber has been replaced by plastic finishes, the substitution has improved the product. Plastic-coated dress shields, for example, last longer and wash better than the rubber variety, and are not as readily affected by perspiration. Hospital sheeting of plastic-coated cottons is lighter, more comfortable, imparts less heat to the body than rubber fabrics, and withstands sterilization requirements.

Plastic-coated raincoats are light in weight, cool and afford good protection. A timely garment is a plastic-coated air-raid warden suit for civilian defense. Baby mattresses and pads are given a transparent coating which does not alter the pattern or coloring of the material and yet prevents damage to the mattress filling. Non-allergic pillow protectors made of plastic-coated cottons banish many a sleepless night for those who are allergic to down and feathers. Economical coated tablecloths, differing from the oilcloth type, will not crack, are easy to clean or may even be laundered. Aprons of coated cotton are the rule for housework, dishwashing and the family laundry. They are waterproof, durable and will outwear the rubber variety. For less severe work, there are plastic-coated rayon aprons with ruffles and frills, plain and printed. Water-repellant taffeta shower curtains feature a plastic coating on the side facing the shower which protects the fabric from mildew, improves its wearing qualities and obviates the necessity of laundering, since the coated surface may be wiped off when soiled.

In addition to these many commercial applications—which are only the beginning of things to come—potential industrial uses for plastic-coated fabrics are as protective coverings for delicate mechanisms, as acid-resistant aprons for factory and laboratory, and for many waterproof products formerly finished with oil and rubber.

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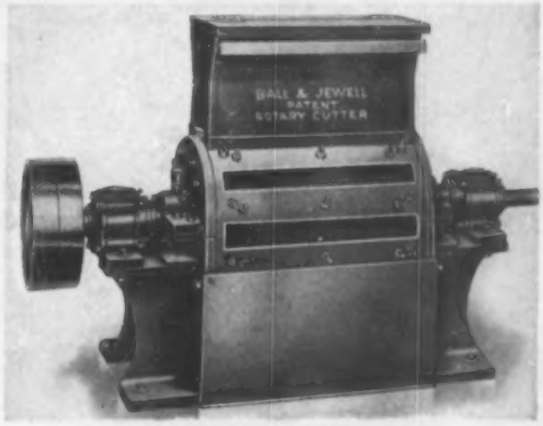

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Drawing clear containers

(*Continued from page 67*) that it just clears the die opening to give the proper shear-off friction at the operating temperatures of the die plate and former. The opening edge of the die plate with this type of cut-off should be very, very slightly rounded with a radius of probably not over $^1/_{64}$ inch. If the cut-off is of the molded type shown in Fig. 3, the cut-off member should be larger than the die plate opening by about 0.005 in. so that the edge of the cut-off strikes the rounded surface of the die opening. The top edge of the die opening must be properly rounded so that line contact, as distinguished from surface contact, is made with the sharp lower edge of the cut-off member.

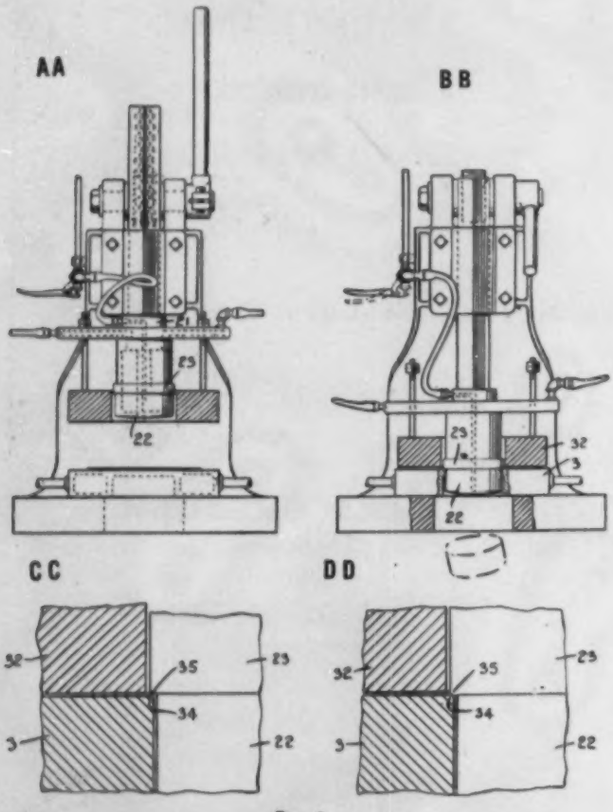

Fig. 3

Heating

Dies may be heated with steam using a good regulating valve and steam pressure gage for control, with hot oil, or with electrical heating units having suitable controls. The die and hold-down plates are heated while the "former" is usually kept relatively cool at about 100 deg. F. The "former" may be ported or channeled for running cooling water through it. The temperature of die and hold-down plates may be from 190 deg. to 275 deg. F depending upon the type of stock used, the thickness of the stock, the size of the container and the amount of draw. The correct temperature for operating must be determined experimentally.

Preparation of blank

Blanks are cut from sheet stock with chop-out or dinking dies under a power press. From 10 to about 30 thicknesses of stock may be cut at a time, depending upon the gage of sheet stock, the size of the blank, the size of the press and the condition of the cutting edge of the die.

In calculating the size of the blank it has been found that the area of the blank is approximately equal to the area of the surface of the formed piece. About $^1/_4$-in. rim should be left between the die and hold-down plates after the cut-off. This rule should be applied for the first trials and then the blank may be made slightly larger or smaller as required to give a minimum of scrap. For example, the size of blank for a container $3^1/_4$-in. diameter by $1^1/_2$ in. deep is calculated as follows:

Area of top..... $\dfrac{3.14 \times 3.25^2}{4} = 8.3$ sq. in.

Area of side..... $3.14 \times 3.25 \times 1.5 = 15.3$ sq. in.

Total area..... 23.6 sq. in.

Diameter of blank having area of 23.6 sq. in. is approximately $5^1/_2$ in.

Method of drawing

The die and hold-down plates are heated to the forming temperature which has been determined by experimental runs on the particular piece being drawn. A blank is placed on the die plate properly centered. Disappearing pins may be placed in the die plate to facilitate centering the blank. The handle is brought downward so that the hold-down plate rests on the blank and pressure is applied to the foot treadle to exert a light pressure on the hold-down plate. The downward stroke of the handle is continued as the stock is drawn into the die. At the end of the stroke additional pressure is applied to the handle to sever the formed piece from the narrow flange remaining between the die and hold-down plates. The piece is then removed from the "former" either by air pressure or by stripper fingers as the plunger is withdrawn. The foot treadle is released and the handle returned to the starting position for the next cycle. The flange remaining on the die plate must be brushed away before a new blank is placed on the die. As production continues cooling water is circulated through the former to maintain a temperature of about 100 deg F.

The speed of drawing depends upon the thickness of the stock, the size of the piece and the depth of the draw. The proper speed must be determined experimentally. The container described above, i.e., $3^1/_4$-in. diameter by $1^1/_2$ in. deep, can be drawn from 0.005-in. stock on a hand press at a rate of about 400 per hour.

General notes

Each job becomes a separate problem and optimum conditions must be established by trial and error. As experience is gained these conditions are quickly established and difficulties are rapidly analyzed and corrected. The following comments should be helpful.

The pressure to be exerted on the hold-down plate is not too critical, but if it is insufficient wrinkles may result. On the other hand, if the pressure is excessive or vice-like it will prevent the stock from sliding and will result in tears or punching through. What is desired is to hold the stock flat while it is being drawn into the die. Wrinkled edges may also result from too much clearance between the die opening and the former or lack of concentricity between these parts.

If the hold-down plate and die surfaces are not smooth and free from nicks, hammer marks and other imperfections, the material will not slide properly and will stick, showing symptoms similar to too much pressure. It is best to lap in the die surface with the surface of the hold-down plate while both are hot. Tears may result from sharp nicks in the die or former. The surface of the former should be smooth and free from nicks but not too highly polished. A high polish may

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7 Highly desirable for precision parts with metal inserts.

8 Available in unit moldings up to 10 feet by 3 feet by 28 inches.

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result in sticking. The former should, however, be cleaned frequently and kept smooth.

It may be necessary to vary the temperature somewhat from time to time. As the operator becomes skilled in the process he will by instinct and feel know whether his dies are heated to the proper temperature and what corrections he should make to obtain perfect pieces.

It is of utmost importance that the press and dies be properly aligned. As the clearances are small the alignment should be just as perfect as it possibly can be made. An inexpensive press can be used, but the machine work and alignment must be excellent.

Background for blueprints

(Continued from page 41) Besides the ease with which the plastic strips are installed, as compared with metal, the material is smooth and warm to the touch.

The office itself is not large, but by the ingenious utilization of every available inch of space, it appears to be much larger. Sliding doors trimmed in plastic were specified instead of the usual hinged doors giving the illusion of one continuous wall. The main office can be made into two separate offices simply by closing a folding door which opens like an accordian.

The ceiling treatment is particularly interesting. Buff-sprayed cellophane tubing $^3/_{16}$ in. in diameter is suspended 3 ft. below the regular ceiling, thus creating a warmer atmosphere than is usually possible in high-ceilinged office buildings. Tubing is grouped in series of two. Each pair is set into the plastic strips which form the framework. Formed from T-shaped cellulose acetate butyrate extrusions, the plastic strips not only support the horizontal tubing but also serve to decorate the joints.

Two overhead lamps were created from stock molded urea reflector bowls and disks. Each lamp consists of a large 3-ft. plywood disk set almost flush to the plastic ceiling. Directly below this is a urea bowl with several smaller molded disks below it, set on an oak base. Extruded molding trims the circumference of the large plywood disk.

The designer's ingenuity is apparent in his treatment of the foyer. Light comes softly through an egg crate ceiling of laminated urea which not only diffuses light rays but also masks the fixtures. On the foyer side of the plastic wall is a glass wall separated from the laminated wall by a hollow area into which the sliding doors fit. Sandwiched between the glass are amusing designs made from trademarks. They cover a variety of fields including liquor, fashion, furniture, transportation, industrial manufacturers and beauty gadgets.

Solid door handles are of transparent methyl methacrylate and blend with the background.

Although the extensive use of plastics relieves metal shortage, this was not Mr. Stott's primary objective. He was interested in the possibilities of these versatile materials for creating novel and unusual effects in good taste. He has achieved his objective with plastics by designing an office that is both functional and decorative.

Credits—Extruded moldings: Tenite II, by Extruded Plastics, Inc. Egg crate ceiling by Insulating Fabricators, Inc., of Lamicoid by Mica Insulator Co. Lamp reflectors: Plaskon Co. Walls: Insurok by The Richardson Co. Door handles: Lucite

3—Cross sectional view shows method of fastening extruded plastic strips for use as molding, edging and decorative trim. Note how the T-shaped piece is inserted and the plastic strip fitted into the corner

PHOTO, COURTESY TENNESSEE EASTMAN CORP.

Soybean protein fibers

(Continued from page 49) pure strains of soybeans are being grown on fields that have been thoroughly analyzed and fertilized. The crop from these fields will be stored in special metal containers in order to keep to a minimum any changes that might occur during storage. We hope by these methods to eliminate as many variables at the source as possible.

3. To produce a fiber the solution first must be prepared for spinning. It is desirable to obtain a solution having a high solids content. Because of the tendency of proteins in high concentrations to form a gel it is very difficult to prepare solutions having more than 12 percent solids. But, by proper control during the extraction of the protein we have succeeded in producing solutions containing 20 percent protein. These solutions have excellent spinning characteristics. They must, however, be aged at the right temperature for the correct time before the proper viscosities and "stringiness" is reached. The solution at this point should contain no undissolved particles or air bubbles which might affect the continuity of the spinning.

4. The next step consists of forcing the solution through the spinnerets into the acid precipitating bath and collecting the filaments on a reel or bobbin. Although many variations in precipitating baths are possible they usually consist of sulfuric acid, formaldehyde and a salt such as sodium chloride or aluminum sulfate to facilitate dehydration of the filaments. Stretching is an important part of the precipitation. The filaments are pulled through the acid bath and over two glass pulleys called Godet wheels. Because the second wheel revolves faster than the first, a stretching effect is exerted on the filaments. For staple fiber work multi-hole spinnerets are used; our usual practice calls for 500-hole spinnerets. A spinning machine having the flexibility required for experimental work is quite complicated. In order to obtain all the features we wanted we had to build our own machine.

Recently we have been working with a continuous machine that will enable us to precipitate, harden and carry out all the after-treatment of the filaments continuously. The uniformity of treatment obtained by the continuous machine is a great advantage in producing fibers because of their minute size and sensitivity. Control of stretching is important as can be shown by producing fibers made from the same

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solution with and without stretching. Those made without stretching will be brittle and weak whereas those that are stretched during the treatment will have good elasticity and high yield points. X-ray defraction studies of fibers show the value of stretching. Orientation occurs when the fiber is stretched under proper conditions, whereas indefinite X-ray patterns are obtained from unstretched fibers.

5. After-treatment of the fiber consists of a relatively long immersion of the fiber in a formaldehyde bath to completely *set* the fiber, cutting it to the desired staple length and drying it under controlled humidity and temperature conditions. The fiber if it has been properly treated will be in a loose, fluffy condition resembling scoured wool.

The finished fiber is white to light tan in color with medium luster. It has a very warm soft feel, natural crimp, and a high degree of resilience. The tensile strength of soybean fiber is about 80 percent as compared to wool, while its dry elongation of 40 percent and wet elongation of 60 percent are much higher. The tensile strength at the break is approximately the same dry and wet; however, the yield point is lower on the wet fiber. The specific gravity of soybean fiber is 1.31 measured in water. The fiber is nearly circular and has very little pigmentation. Water does not wet soybean fiber as readily as it does casein fiber and wool. Preliminary experiments indicate that soybean fiber is very resistant to the action of mold as compared to casein fiber which is more readily attacked. Fiber sizes range from $1^1/_2$ denier to 5 denier in staple lengths of $1^1/_2$ in. to 6 in. It can be produced in natural color or spun dyed with or without a fixed, highly permanent crimp.

Recent refinements in processing have produced a soybean fiber more resistant to carbonizing and to boiling in dilute acid and alkali. The fiber has been handled on conventional cotton and worsted equipment and shows great promise as a new, distinctly different fiber eminently suited in wool blends for use in suitings and upholstery fabrics. The availability of the fiber in fine deniers with a fine crimp and great resilience indicates its usefulness with cotton and spun rayon in the development of many new materials. Still another development that is being investigated is the use of soybean fiber with wool in felt manufacture.

While there remains a tremendous amount of work to be done on soybean fiber, we feel that the results so far warrant proceeding with the program as fast as possible. Plans are now going forward for the installation of a complete mill capable of producing 1000 lbs. per day of finished fiber in the form of "top" suitable for blending with fibers used in automotive upholstery.

Styramic for insulation

(*Continued from page 70*) size similar to the test specimen and under loads comparable to those used in the above experiments, should be in the neighborhood of 175 deg. F. (80 deg. C.).

None of the aforementioned data, however, takes into account distortion or unmolding due to stress-relief that may occur when molded pieces are subjected to high temperatures. Figure 6 shows percent shrinkage due to stress-relief as a function of time at 100 deg. C. for a $^1/_4$ in. by $^1/_4$ in. injection-molded bar under no load. It may be noted that whereas the polystyrene bar shrunk more than 18 per cent in one hour, the bar molded from the chlorinated-diphenyl-polystyrene compound shrunk only 3.5 percent.

In conclusion, it can be said that the chlorinated-diphenyl-

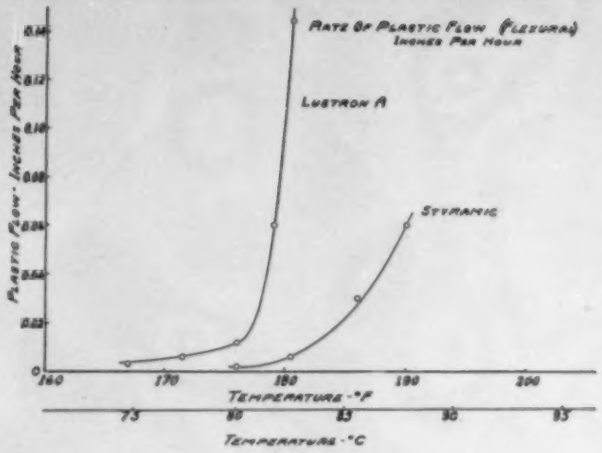

Fig. 5

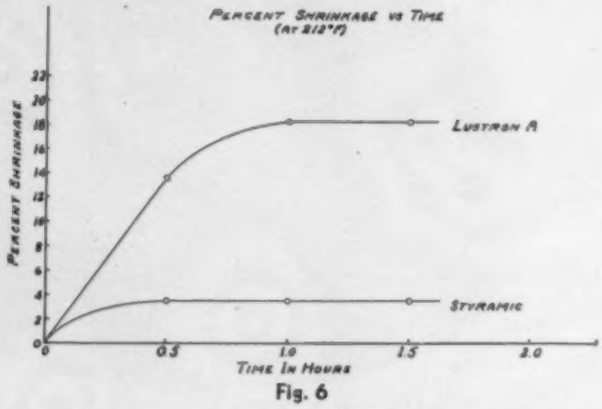

Fig. 6

polystyrene compound presents to the industry a plastic superior to others now known for high frequency electrical insulation. It is characterized by excellent electrical properties, better heat resistance than other readily available thermoplastics and non-flammability. The chlorinated-diphenyl-polystyrene compound is not recommended for those applications where unusually high operating temperatures are encountered over a long time. However, there are many applications today where it may be used advantageously.

An engineer looks at plastics

(*Continued from page 57*) pact test bar which is filled from both ends, causing a weld to form at the center of the test bar. With such a specimen the strength of the weld may be determined after varying the molding conditions. The presence of welds in acetate parts can be sharply revealed by soaking the parts in a solution of 30 percent acetone, balance water.

5. Effect of molding method, machinery, die design, press cycle, use of inserts, etc., on the serviceability of the part. This is usually determined by life tests on the parts themselves. No other method seems available until sufficient experience has been gained to form a background for design. At the present time the art is being developed by every new part made.

6. Methods of test to determine and control these properties and to establish the compound as a specific thing. Chemical tests are under investigation by the various standardizing bodies and by the industry. These are resulting in methods of test and in specifications which are now appearing as tentative.

(*Please turn to page 110*)

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7. Specifications and methods of test that will properly control the properties that are of interest both from the standpoint of the producer and the consumer. A start has been made in the development of test methods by the American Society for Testing Materials. Material specifications for phenol plastic have been made available by A.S.T.M. Army and Navy methods of test are also under study. There are no available specifications on the majority of thermoplastic materials. This is due to the newness of the field and the fact that the engineering uses are slow to get under way because of the time required to develop test methods. Table VII gives a list of the standards adopted by the A.S.T.M. These relate principally to methods of test. Table VIII shows the plastic test methods under development by A.S.T.M. and Table IX shows the tests in the Navy specifications on phenol plastics. Table X shows the testing procedures for aircraft plastics under consideration. It will be noted that most of these tests relate to end point tests which are closely allied to service. (*Please turn to page 112*)

TABLE VII.—STANDARDS AND TENTATIVE A.S.T.M. STANDARDS

Electrical	*Resistance to Chemical Reagents*
Power factor	Standard, such as:
Resistivity	Sulfuric acid (30 percent)
Dielectric strength	Acetone, etc.
Arc resistance	
	Supplementary, such as:
Mechanical	Nitric acid (10 percent)
Tensile	Ammonium hydroxide (10 percent)
Impact	
Flexural	
Compression	
Deformation under load	*Others*
Mar	Particle size
	Bulk factor
Optical	Powder pourability
Surface irregularities	Sampling powder
Diffusion	Preconditioning
Color fastness	Flammability

TABLE VIII.—PLASTIC TEST METHODS UNDER DEVELOPMENT BY THE A.S.T.M.

Modulus of elasticity	Flow of thermoplastic materials
Repeated impact	
High speed impact	Flow of thermosetting materials
Impact under tension	
Creep	Effect of heat
Long-time tension creep	Scratch hardness
Long-time fracture	Haze
Torsion	Reflection factors
Fatigue	Polarization
Thermal expansion	Optical clarity
Machinability	Surface brightness
Wear	Accelerated weathering

TABLE IX.—NAVY SPECIFICATION ON PHENOL PLASTIC LIST OF TESTS

Materials and workmanship	Test of identity:
Visual	Inorganic residue
Water absorption	Hardness
Volume resistance	Specific gravity
Insulation resistance	Water absorption
Dielectric strength	Impact
Power factor and dielectric constant	Flexural
	Tensile
Machinability	Compressive
Distortion under heat	Hot oil bath
Acetone extraction	

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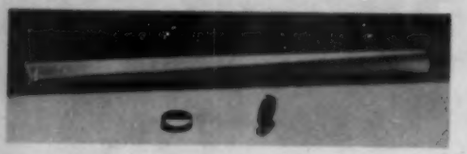

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TABLE X.—TESTING PROCEDURES FOR AIRCRAFT PLASTICS

Preconditioning	Impact
Speed of testing	Indentation hardness
Tensile	Durability
Elongation	Rate of burning
Compression	Moisture absorption
Flexural	Immersion in gasoline, oil and solvents
Shear	
Bearing test	Heat distortion
Fatigue	Thermal expansion
Static tensile	Lap joint

Present situation

Reviewing the field as a whole, it may be said that the development of technical tests for the control of plastics is well under way. There is a serious difficulty in that the manufacturer does not reveal his formulation. The result is that the purchaser has no information concerning the effect of ingredients on the compound. Chemical tests so far do not provide adequate control over composition. The electrical tests appear to be satisfactory. Mechanical tests are available for thermosetting compression molded materials. Tests for thermoplastic materials are being developed.

Molding methods

There is comparatively little information available either on injection molding or extrusion of thermoplastics due to the newness of the art. At the present time the study of specific uses is the controlling factor in the engineering of plastics in the absence of systematic knowledge.

Future developments

It is believed that defense restrictions will do much to stimulate development of substitute materials. Startling developments in wood and cellulosic products employing natural and synthetic bonding materials are expected. A combination of ground wood pulp and adhesive may provide products that are cheap and abundant. Developments of consolidations whereby two or more plastics are used together (such as cellulose acetate surfaced phenol plastic or cellulose acetate coated lignin fiber) are possibilities. Molding dies are still the principal bottleneck in the industry and tend to limit the size of parts due to their cost and the tremendous total pressures that must be used. We need plastic materials that will set and flow at low pressures. It is imperative that every effort be made to develop cheaper methods of manufacture and production of dies.

Deformation of plastics

(*Continued from page 72*) the sampling method described in Paragraph (*c*) which averages the effect over the sheet by selecting squares comprising the specimen in such a manner that each square represents the same proportional part of the entire sheet area.

(*c*) *Specimen from sheet materials.*—The specimen shall be selected from the whole sheet by cutting a strip 1/2 in. in width from the sheet, parallel to the two long edges if the sheet is not square or parallel to any two if it is square, midway between them, and extending from the edge to the center of the sheet. If quarter sheets are used, the strip shall be taken from the edge corresponding to the center-to-edge section of the original whole sheet. The strip shall be divided into eight equal parts numbered from 1 to 8, beginning with

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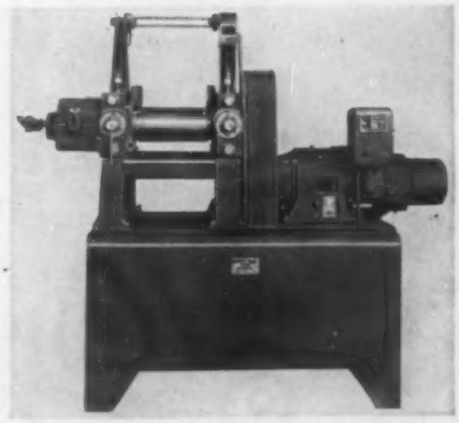

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the piece corresponding to the edge of the sheet. The squares used to form the composite test specimen shall be taken from these pieces. If the whole piece is not used, the squares cut from it shall be taken from the end which was originally nearest the edge of the sheet. If any piece is insufficient for the number of squares required to be cut from a piece bearing that number, a second strip shall be cut adjacent to the first one, cut into pieces, and the required number of squares taken from the appropriate pieces. The number of squares to be cut from each piece is prescribed in Table I.

TABLE I. NUMBER OF SQUARES TO BE CUT FROM EACH PIECE

Thickness of Material, In.	Total Number of Squares Required	Number of Piece							
		1	2	3	4	5	6	7	8
1/64	32	8	6	6	4	3	3	2	...
1/32	16	4	3	3	2	2	1	1	...
3/64	11	2	2	2	2	1	1	1	...
1/16	8	2	1	1	1	1	1	1	...
5/32	5	1	1	1	1	...	1	...	...
1/8	4	1	1	1	...	1	...	...	...
3/16	3	1	...	1	...	1	...	...	...
3/8	1	...	...	1	...	...	...	...	...
1/2	1	...	...	1	...	...	...	...	...

NOTE.—In case of material of thicknesses not included in the above table, the squares used in the composite test specimen shall be selected in accordance with the method for nearest thickness given in the table. In case the thickness is midway between two adjacent values in the table, the squares used in the composite test specimen shall be selected in accordance with the instructions for the thinner material.

Conditioning and testing procedure

5. (*a*) Before testing, the specimens shall be preconditioned for 4 hr. at 65 ± 3 deg. C. (150 ± 5 deg. F.) and then conditioned for 68 hr. at a temperature of 35 ± 1 deg. C. (95 ± 2 deg. F.) and a relative humidity of 90 ± 2 percent, unless otherwise specified. The specimens shall be supported during conditioning upon a 1/8-in. mesh wire screen or the equivalent in order to permit free access of the atmosphere to all specimens.

(*b*) The test temperature, that is, the temperature of the chamber containing the testing apparatus shall be maintained at 50 ± 0.5 deg. C. (122 ± 1 deg. F.), unless otherwise specified.

(*c*) In any case where it is definitely established that the material is not affected by moisture, the preconditioning and conditioning may be omitted.

Procedure

6. (*a*) The conditioned test specimens shall be placed between the anvils of the testing machine immediately upon removal from the conditioning atmosphere. The specimens tested without conditioning shall be at room temperature when placed in the testing machine. Where composite specimens are used, care shall be taken to insure that the squares are well aligned.

(*b*) The load shall be applied to the specimen without shock and the initial reading taken as soon as the full load is upon the specimen, as indicated by a sudden

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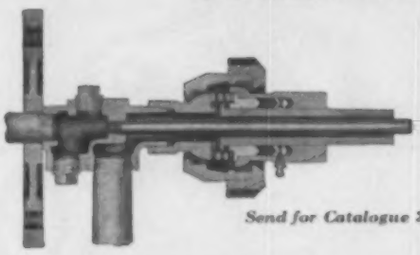

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slowing of the rate of travel of the gage. At the end of 24 hr., a second reading shall be taken and the total change in height in mils shall be recorded. The original height in mils of the specimen shall be determined by measuring the specimen after it is removed from the testing machine and adding to this the total change in height as read on the dial of the testing machine.

(*c*) The deformation shall be taken as the percentage change in height of the test specimens after 24 hr., calculated as follows:

$$\text{Deformation, percent} = \frac{A}{B} \times 100$$

where:

A = change in height in mils in 24 hr., and
B = original height in mils.

Report

7. The report shall include the following:

(1) Original height of test specimen in mils,

(2) Thickness of components in mils where a composite test specimen is used,

(3) Change in height of the test specimen in 24 hr. in mils, and

(4) Deformation (flow or combined flow and shrinkage) expressed as the percentage change in height of the test specimen calculated on the basis of its original height.

Sorry!

★ ON PAGE 62 OF OUR JANUARY ISSUE, THE TITLE OF A. J. Weith of the Bakelite Corp. should read "Director of Research and Development."

★ IN THE SAME ISSUE ON PAGE 78, THE NEW AMERICAN Molding Powder & Chemical Corp. was erroneously reported as a dealer in scrap materials. The company manufactures only cellulose acetate molding powder.

★ IN THE "CONSTRUCTION OF MOLDS" ARTICLE which appeared in the 1942 PLASTICS CATALOG, a typographical error was made in Table I, page 238. In referring to case-hardening mold steel No. 1, the tensile strength shown as 510,000 p.s.i. should read 105,000 p.s.i.

★ IN THE DIRECTORY SECTION OF THE 1942 PLASTICS CATALOG an error was made in the address of the Packless Metal Products Corp. The company has moved to newer and larger quarters at 31 Winthrop Ave., New Rochelle, N. Y. (telephone, New Rochelle 2-3830). Manufacturers of flexible metal hose and Flex-Control units for hydraulic presses and other equipment, the company occupies over 80,000 sq. ft. in its own building at that address.

★ FROM IMPERIAL CHEMICAL INDUSTRIES (NEW York), Limited, 285 Madison Ave., New York, comes a letter from the firm's London associates, anent a statement made in MODERN PLASTICS, Aug. 1941 issue regarding nylon manufacture in England, which says in part: "This statement announced that Messrs. Courtaulds Ltd. have started a new company, British Nylon Spinners Ltd., which is already in production, and contains the sentence: 'Imperial Chemical Industries are also reputed to be starting nylon production over here' (i.e., in England). This statement is calculated to lead to misunderstanding. The position is that the nylon patents have been exclusively licensed by Messrs. du Pont to Imperial Chemical Industries Ltd. in a territory comprising the British Empire and Mandates, with the exception of Canada. Imperial Chemical Industries have in turn sublicensed British Nylon Spinners Ltd., a firm formed jointly by Imperial Chemical Industries and Messrs. Courtaulds Ltd., to manufacture nylon yarn. All the other manufactures of nylon, such as monofil, will be made by Imperial Chemical Industries." MODERN PLASTICS is glad to print this clarification of its original statement.

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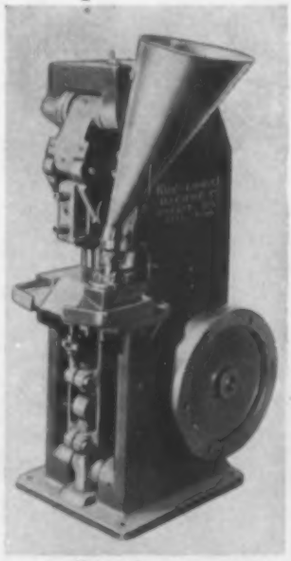

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